Mines and Minerals Division
Ontario Geological Survey
Study 32

Geology of Carbonatite – Alkalic Rock Complexes in Ontario: Lackner Lake Alkalic Rock Complex District of Sudbury

by R. P. Sage

1988

Ontario
Ministry of
Northern Development
and Mines

© 1988 Queen's Printer for Ontario
Printed in Ontario, Canada
ISSN 0704-2590
ISBN 0-7729-0567-3

Publications of the Ontario Geological Survey and the Ministry of Northern Development and Mines are available from the following sources. Orders for publications should be accompanied by cheque or money order payable to the *Treasurer of Ontario*.

Reports, maps, and price lists (personal shopping or mail order):
Public Information Centre, Ministry of Natural Resources
Room 1640, Whitney Block, Queen's Park
Toronto, Ontario M7A 1W3

Reports and accompanying maps only (personal shopping):
Ontario Government Bookstore
Main Floor, 880 Bay Street
Toronto, Ontario M7A 1N8

Reports and accompanying maps (mail order or telephone orders):
Publications Services Section, Ministry of Government Services
5th Floor, 880 Bay Street
Toronto, Ontario M7A 1N8
Telephone (local calls), 965-6015
Toll-free long distance, 1-800-268-7540
Toll-free from area code 807, 0-ZENITH-67200

Canadian Cataloguing in Publication Data

Sage, R. P.

Geology of carbonatite-alkalic rock complexes in Ontario

(Ontario Geological Survey study, ISSN 0704-2590 ; 32)
Includes index.
ISBN 0-7729-0567-3

1. Carbonatites—Ontario—Lackner Lake Region. 2. Alkalic igneous rocks. I. Ontario. Ministry of Northern Development and Mines. II. Ontario Geological Survey. III. Title. IV. Series.

QE461.S23 1988 549'.1142 C88-099611-0

Every possible effort is made to ensure the accuracy of the information contained in this report, but the Ministry of Northern Development and Mines does not assume any liability for errors that may occur. Source references are included in the report and users may wish to verify critical information.

If you wish to reproduce any of the text, tables or illustrations in this report, please write for permission to the Director, Ontario Geological Survey, Ministry of Northern Development and Mines, 11th Floor, 77 Grenville Street, Toronto, Ontario M7A 1W4.

Parts of this publication may be quoted if credit is given. It is recommended that reference to this report be made in the following form:

Sage, R.P.
1988: Geology of Carbonatite – Alkalic Rock Complexes in Ontario: Lackner Lake Alkalic Rock Complex, District of Sudbury; Ontario Geological Survey, Study 32, 141p.

1000-88-General Printers

Foreword

The Lackner Lake Alkalic Rock Complex was examined as part of a project to study alkalic rock – carbonatite complexes in Ontario. The study describes the rock types and mineralogy of the complex and outlines the history of the mineral exploration efforts within the complex.

V.G. Milne

Director
Ontario Geological Survey

Contents

Abstract 2
Résumé 2
Introduction 3
Acknowledgments 3
Location And Access 4
Field Methods 4
Previous Geological Work 4
Physiography 4
Laboratory Techniques 6
Nomenclature 6
General Geology 8
Early Precambrian (Archean) 9
Gneiss 9
Early To Middle Precambrian 11
Dike Rocks 11
Late Precambrian (Proterozoic)
Lackner Lake Alkalic Rock Complex 11
Massive Ijolite, Ijolite Breccia 11
Portage Lake Complex (Ijolite) 13
Foliated Ijolite, Malignite And Nepheline Syenite 14
Unfoliated Syenitic To Ijolitic Rocks 16
Mesocratic Nepheline Syenite 16
Mesocratic To Melanocratic Malignite And Ijolite 17
Mesocratic To Leucocratic Nepheline Syenite To Malignite .. 18
Other Unfoliated Syenitic Rocks 20
Carbonatite 21
Magnetite And Magnetite–apatite Veins 22
Dike Rocks 24
Petrology 24
Petrogenetic Model 1 25
Petrogenetic Model 2 30
Magnetite–apatite 31
Geochronology 32
Metamorphism 32
Structural Geology 34
Regional Setting 34
Local Structure 35
Magnetic And Radioactive Data 36
Recommendation For Future Study 36
Economic Geology 37
Property Descriptions 44

Apamag Mines Limited 44
Chyka Mines Limited 45
Claymac Mines Limited 45
Dominion Gulf Company 45
Falconbridge Nickel Mines Limited 45
MacDonnell–LeBrasseur–Derraugh 46
Multi–Minerals Limited 47
Multiwin Explorations Limited 52
Naneck Mines Limited 52
Ontario Rare Metal Mines Limited 52
M. Silverman Claims 52
Union Carbide Canada Mining Limited 52
Recommendations To The Prospector 52
Appendix A — Petrographic Descriptions, Chemical Analyses And Normative Compositions Of Samples From The Lackner Lake Alkalic Rock Complex. 54
References 133
Index 136

TABLES

1. Lithologic Units For The Lackner Lake Alkalic Rock Complex. ... 10
2. Average Electron Microprobe Analyses Of Pseudoleucite And Constituent Nepheline And Feldspar 21
3. Descriptions Of Samples Used For Age Determination By Rubidium–Strontium Isochron 33
4. Analyses Of Pyrochlore From Multi–Mineral's Property 37
5. Chemical Composition Of Magnetite From Magnetite–Apatite Zone 39
6. Cerianite Composition 39
7. Rare Earth Elements in Multi–Minerals Apatite Concentrate. 40
8. Exploration Programs At Lackner Lake. 40
9. Summary Of Diamond Drilling at Lackner Lake 41
10. Estimated Reserves Of Mineralized Zones Of The Lackner Lake Alkalic Rock Complex 41
11. Spectrographic Analyses Of Magnetite–Apatite Samples 42
12. Assays For Uranium And Niobium In Various Mineralized Zones . 47
A–1. Petrographic Descriptions Of Whole–Rock Samples 54
A–2. Major Element Analyses Of Whole–Rock Samples 76
A–3. Trace Element Analyses Of Whole–Rock Samples 84
A–4. Normative Minerals (CIPW Norm) For Whole–Rock Samples 99
A–5. Normative Minerals (Alkalic Rocks) For Whole–Rock Samples ... 114
A–6. Average Chemical Compositions Of Lithologic Units 129

FIGURES

1. Key map 5
2. Aeromagnetic map of the Lackner Lake Complex 8
3. Geology of the Lackner Lake Complex ..... Chart A
4. AFM plots of samples from the Lackner Lake Complex 27
5. Rb/Sr isochron plot of whole–rock samples and separated minerals from the Lackner Lake Complex. 33
6. Vertical section across Multi–Minerals' No. 3 and No. 4 zones ... 48
7. Vertical section through centre of Multi–Minerals' No. 6 zone 50

8. Vertical section through the east end of Multi-Minerals' No. 6 zone 50
9. Vertical section through Multi-Minerals' No. 8 zone 51

PHOTOS

1. Angular fragments of ijolite and magnetite in nepheline syenite ... 12
2. Nepheline syenite veining ijolite 12
3. Pseudoleucite crystals in nepheline syenite 20

CHART A (back pocket)

Chart A (coloured) — Figure 3.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in cooperation with the Coal Association of Canada.

Geology of
Carbonatite – Alkalic Rock Complexes in Ontario:
Lackner Lake Alkalic Rock Complex
District of Sudbury

R.P. Sage[1]

1. Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto. Manuscript approved for publication, May 31, 1983, by the Chief Geologist, Ontario Geological Survey.

This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

The Lackner Lake Alkalic Rock Complex consists of arcuate bands and partial rings of ijolite, malignite, and nepheline syenite. Minor carbonatite is associated with the malignite and ijolite rocks. The complex has been emplaced into gneisses of the Kapuskasing Structural Zone and has been dated by rubidium–strontium isotopic techniques at 1138 ± 29 Ma.

The complex is known to host uranium, thorium, rare earth elements, apatite and titaniferous magnetite mineralization and has been extensively prospected for niobium. Diamond drilling has outlined four zones of low grade niobium mineralization which together total in excess of 110 million tonnes.

The complex appears to have future economic importance as a potential low grade source for niobium with a number of possible mineral by–products.

Résumé

Le complexe de roches alcalines du Lac Lackner est formé de bandes arquées et d'anneaux incomplets d'ijolite, de malignite et de syénite à néphéline. On trouve une petite quantité de carbonatite dans les roches en malignite et en ijolite. Le complexe est enchâssé dans des gneisses de la zone structurale de Kapuskasing; on a pu le dater grâce à des procédés isotopiques au rubidium–strontium à 1138 ± 29 Ma.

On sait que le complexe contient de l'uranium, du thorium, de rares éléments terrestres, de l'apatite et de la magnétite titanifère minéralisés; on y a intensivement prospecté du niobium. Le forage au diamant a permis de déterminer quatre zones de niobium minéralisé à faible teneur représentant ensemble plus de 110 millions de tonnes.

On pense que ce complexe prendra de la valeur comme source potentielle de niobium à faible teneur associé à un certain nombre de sous–produits minéraux possibles.

Geology of Carbonatite – Alkalic Rock Complexes in Ontario: Lackner Lake Alkalic Rock Complex, District of Sudbury, by R.P. Sage. Ontario Geological Survey, Study 32, 141p. Published 1988. ISBN 0–7729–0567–3.

Introduction

The Lackner Lake Alkalic Rock Complex was examined as part of a Province–wide program to economically evaluate alkalic rock – carbonatite complexes. Examination of the complex was restricted to sampling for chemical and petrographic analysis, using maps prepared by Parsons (1961) as a geological base. The results of extensive exploration programs on the complex for economic mineral deposits have been previously discussed by Parsons (1961) and Hodder (1961). The rock exposures are now largely overgrown and the diamond drill core from these programs has been lost. The present report was originally prepared in 1976–1977; additions and modifications were made in 1979–1980 and 1985 to incorporate new analytical and exploration data.

The Lackner Lake Alkalic Rock Complex intrudes Early Precambrian rocks of the Kapuskasing Structural Zone of the Superior Province of the Canadian Shield. The complex is circular in form and consists of a series of arcuate ridges of ijolite (nepheline – pyroxene rock), malignite (nepheline – pyroxene – alkali feldspar rock), and nepheline syenite. The mafic phases of the complex have been cut by niobium–bearing carbonatite dikes. The complex is one of several alkalic rock – carbonatite complexes of similar age that occur within the Kapuskasing subprovince.

Exploration companies working on the complex have outlined niobium, iron, apatite, rare earth and uranium mineralization.

Acknowledgments

The complex was originally mapped by Parsons (1961), and his report and map were invaluable aids to the present project. Parsons report and map are now out of print, and some material from his report, particularly concerning economic geology, has been incorporated in the present report. Parsons' map was used as a base map for this project, and has been reproduced with only minor changes and additions as Figure 3 (Chart A, back pocket).

The author was assisted in mapping in 1976 by W. Wright, P. Chamois, and C. Higgins. Mr. Wright as senior assistant did most of the traversing on the complex. The author examined the east canyon in the northeast corner and completed a traverse in the southwest corner. The author combined the data obtained by Mr. Wright during the present survey with data and observations previously made by the author during mapping of the Chapleau area (Thurston *et al.* 1977). As part of that project, the author examined outcrops in the southwest corner of the complex, and in the west canyon in the northeast corner.

Mr. S. Charteris, Exploration Manager, Falconbridge Nickel Mines Limited, Mr. Walter H. Thompson, Gulf Minerals Canada Limited, and Mr. H. A. Pearson, formerly Vice–President, Exploration, Multi–Minerals Limited, have made available private data concerning exploration activity on the complex. These data are on public file in the Assessment Files Research Office, Ontario Geological Survey, Toronto.

Mr. Martin Burton, president, Multi–Minerals Limited, donated the records for the 1978–1979 program that tested the uranium potential of the complex. Mr. Ross Kidd, Consulting Mining Engineer for Multi–Minerals Limited, conducted this program.

Location and Access

The Lackner Lake Complex is located in Lackner and McNaught Townships and is centred at approximately 47°47'N Latitude and 83°06'W Longitude (Figure 1). The complex has a surface area of approximately 28 km². The complex can be reached most easily by a gravel road that turns off Highway 129 approximately 16 km south of Chapleau. This gravel road runs in a general north to northeasterly direction from Highway 129 for a distance of approximately 39 km and terminates at the Multi–Minerals Limited property located in the southwest corner of the complex. A driveable trail extends from the southwest corner of the complex to an abandoned fire tower on the north side of the complex. Some of the trails and/or roads shown by Parsons (1961) are no longer passable by motor vehicles.

Field Methods

Mapping of the Lackner Lake Complex was plotted on acetate overlays on 1:15,840 airphotos supplied by the Air Photo Library of the Ontario Ministry of Natural Resources. Data from the airphotos were transferred to a cronoflex base map at the same scale. The base map was prepared from Ontario Department of Mines Map 2008 (Parsons 1961). Traversing and sample collecting were based on the outcrop data reported by Parsons (1961). Some data were compiled from notes and samples prepared during Operation Chapleau (Thurston *et al.* 1977).

Traversing of the complex by compass is difficult and locally impossible due to isolated pods and veins of magnetite in the bedrock.

Previous Geological Work

The Lackner Lake Complex has been studied by several investigators. Hodder (1958) initially published a brief paper on the complex and subsequently completed a more detailed study (1959) as part of a Ph.D. thesis at the University of California. The results of this study were published by the Geological Survey of Canada (Hodder 1961). Unpublished theses on the complex include those of Neczkar (1958) and Scott (1963).

Parsons (1961) prepared a report on this complex for the Ontario Department of Mines, and the author wrote a brief description of the complex as part of a regional reconnaissance mapping program (Thurston *et al.* 1977). The author finds little disagreement with the previous work of Parsons (1961). The sequence of Parsons' map–units has been changed, on the basis of field relationships observed by the author at Lackner Lake and other alkalic rock – carbonatite intrusions within Ontario. The author has not changed the areal distribution of the lithologies established by Parsons.

Physiography

Outcrop on the complex is not abundant even though this complex is probably the best exposed of the carbonatite – alkalic rock complexes in the Kapuskasing Structural Zone. Outcrop is most abundant along the west and north sides of the complex. The centre, and south and east sides have only the occasional isolated outcrop. The complex forms a prominent topographic high with hills rising 150 m above the typical, undulating topography of the Canadian Shield. Lackner Lake occupies the centre of the complex and has a generally marshy shoreline. Two canyons on the northeast rim of the complex provide the best exposures available for examination.

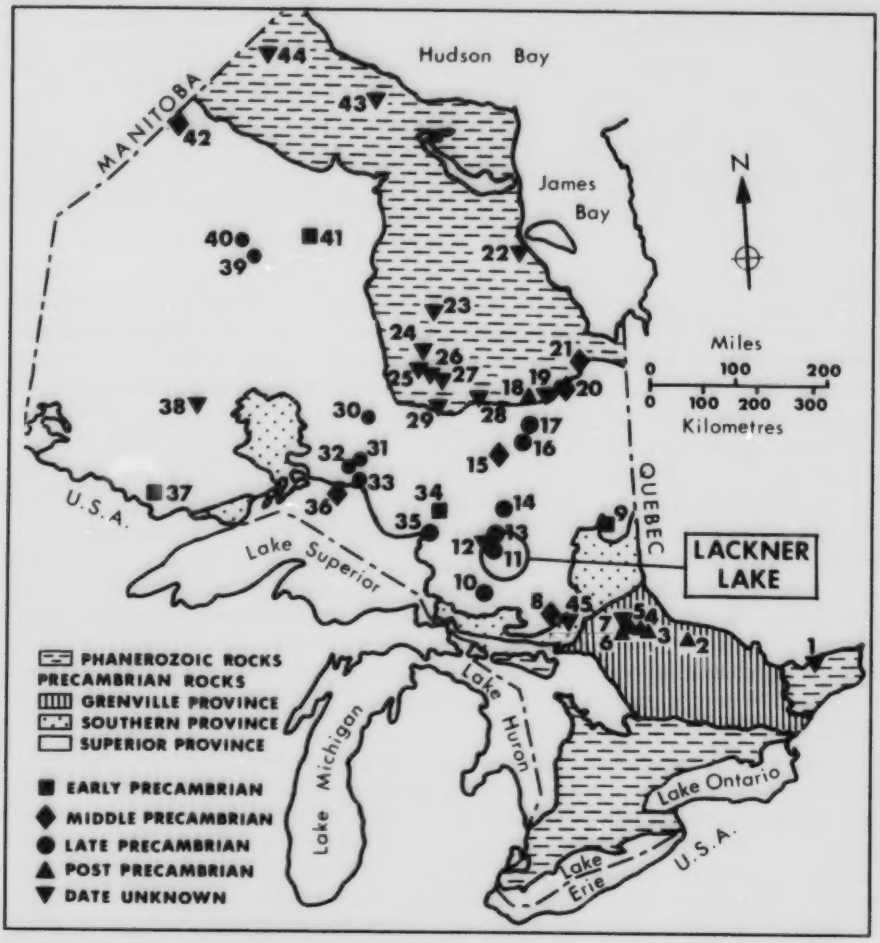

Figure 1. *Key map showing location of carbonatite – alkalic rock complexes in Ontario.*

1. *Eastview*
2. *Brent*
3. *Callander B.*
4. *Manitou Is.*
5. *Burritt Is.*
6. *Iron Is.*
7. *Lavergne*
8. *Spanish R.*
9. *Otto Stock*
10. *Seabrook L.*
11. **Lackner L.**
12. *Borden Tp.*
13. *Nemegosenda L.*
14. *Shenango Tp.*
15. *Cargill Tp.*
16. *Teetzel Tp.*
17. *Clay-Howells*
18. *Hecla-Kilmer*
19. *Valentine Tp.*
20. *Goldray*
21. *Argor*
22. *Lawashi R.*
23. *Poplar R.*
24. *Albany Forks*
25. *L. Drowning R.*
26. *Kingfisher R. West*
27. *Kingfisher R. East*
28. *Martison L.*
29. *Nagagami R.*
30. *Chipman L. (dikes)*
31. *Killala L.*
32. *Prairie L.*
33. *Port Coldwell*
34. *Herman L.*
35. *Firesand R.*
36. *Slate Is.*
37. *Poohbah L.*
38. *Sturgeon Narrows & Squaw L.*
39. *Schryburt L.*
40. *Big Beaver House*
41. *Wapikopa L.*
42. *"Carb" L.*
43. *Gooseberry Br.*
44. *Niskibi L.*
45. *Nemag L. & Lusk L.*

Laboratory Techniques

Samples were collected for thin section and chemical analysis. Slabs submitted for total rock analysis were trimmed to remove any alteration and weathered rock. Xenolithic fragments, where present, were removed with a diamond saw. All rocks submitted for analysis were thin sectioned. The sections were half stained for potassium feldspar to aid in determining feldspar compositions. Petrographic descriptions (Table A–1) based on brief examination accompany the chemical data in Appendix A.

Nomenclature

The various lithologic units of the complex were originally classified and named by Parson (1961). The author has used a somewhat different nomenclature in the present report, in conformity with the nomenclature used in describing other alkalic rock – carbonatite complexes in northern Ontario. For the alkalic rocks, the author prefers to use mineralogic, colour, or textural modifiers, which are familiar to all readers, rather than unfamiliar rock names. Alkalic rock nomenclature is cumbersome, due in large part to the profusion of unfamiliar rock names. Consequently, as an aid to the reader, the use of less familiar rock names will be limited. The rock terms retained by the author and the way they are used are given below.

Ijolite. A nepheline–pyroxene rock with a nepheline content between 30 and 70 percent. Rocks containing more than 70 percent nepheline are classified as urtite and those with less than 30 percent as melteigite. Some specimens may contain significant amounts of biotite in place of pyroxene. Potassium feldspar content is 10 percent or less and those rocks with 10 percent or less nepheline are classified as pyroxenite.

Malignite. A melanocratic nepheline syenite. In general, nepheline, pyroxene and potassium feldspar occur in roughly equal proportions. The potassium feldspar content must exceed 10 percent or the rock is classified as belonging to the ijolite suite. Both the nepheline and pyroxene content must exceed 10 percent or the rock would be classified with the syenites. This rock group is transitional between the ijolites and overlaps the syenitic rock groups.

Sovite. A carbonatite rock composed of 50 percent or more calcite. Various mineralogic modifiers are used to classify the sovite, for example, apatite–magnetite sovite, olivine–amphibole sovite, etc.

Silicocarbonatite. A carbonatite rock containing 50 percent or more oxide and silicate minerals. Where the silicate or oxide mineralogy exceeds 90 percent various other rock names are applied, i.e. ijolite, biotite, pyroxenite, etc.

Syenite. This term is restricted to a quartz–free rock consisting primarily of alkali feldspars. Various mafic minerals and nepheline may be present and form a significant component of the rock. The syenites are named on the basis of their mineralogy, i.e., pyroxene–nepheline syenite, biotite–amphibole syenite, etc. The syenites are gradational into malignites.

There is no standard subdivision of the ijolite suite into ijolite, urtite, and melteigite. Bailey (1974) classified urtites as having more than 70 percent nepheline, however he uses the term ijolite to apply only to those rocks containing between 50 and 70 percent nepheline. The author finds this range to be too restricted for field use and prefers the 30 to 70 percent range given by Williams *et al.* (1954, p.70).

Malignite from the Poohbah Lake Complex in northwestern Ontario was originally defined by Lawson (1896) as an alkali–rich rock containing pyroxene,

and potassium feldspar, with or without nepheline, garnet and amphibole. The author has examined the malignite of this complex in the field and in a large number of thin sections. The malignites are melanocratic and contain pyroxene, nepheline, orthoclase, garnet, and amphibole. The nepheline content of the type location is relatively low compared with the definition given above. For field work and to better emphasize the gradational nature of malignite into ijolites and syenites without the use of cumbersome terminology, a broader usage of the term has been applied by the author. Williams *et al.* (1954, p.65–66)described a number of malignites of varying mineralogy.

The Poohbah Lake type location for malignite was re–investigated by Mitchell and Platt (1978) and malignite was redefined by them as a nepheline syenite containing oikocrystic potassium feldspar. The author considers the definition of Mitchell and Platt too restrictive. In this report, the term malignite is used, as defined by Sorensen (1974, p.27), for a melanocratic nepheline syenite.

The definitions of sovite and silicocarbonatite are modified from Heinrich (1966, p.12). The author has found Heinrich's subdivision of the carbonate–rich carbonatitic rocks generally suitable for field usage when modified to a two–fold subdivision at about 50 percent oxide and silicate mineral contents. The two–fold subdivision is more convenient than the four–fold subdivision of Heinrich (1966) because carbonatites show extreme variations in mineral content over distances of less than a few centimetres. It is difficult to rigorously classify such heterogeneous rocks.

General Geology

The shape of the Lackner Lake Complex is well illustrated on aeromagnetic map 2232G (ODM–GSC 1963) by a strong, prominent, circular aeromagnetic anomaly (Figure 2) over the intrusion. The anomaly is caused by concentrations of magnetite within the more mafic phases of the intrusion. Gittins *et al.* (1967) reported a K–Ar age of 1090 Ma for the complex, Owen and Faure (1977) reported a rubidium–strontium isochron age of 1078 ± 7 Ma, and Bell and Blenkinsop (1980) obtained a rubidium–strontium age of 1138 ± 29 Ma.

The complex (Figure 3, Chart A, back pocket) consists of peripheral and core nepheline syenites, separated by a medial, arcuate, partial ring of alkalic mafic rocks (ijolite and malignite). The coarse– to very coarse–grained, leucocratic nepheline syenites of the core and periphery cannot be differentiated by mineralogy, textural or crosscutting field relations. In proximity to the arcuate band of mafic rocks, the syenites are locally finer–grained, have a strong to weak

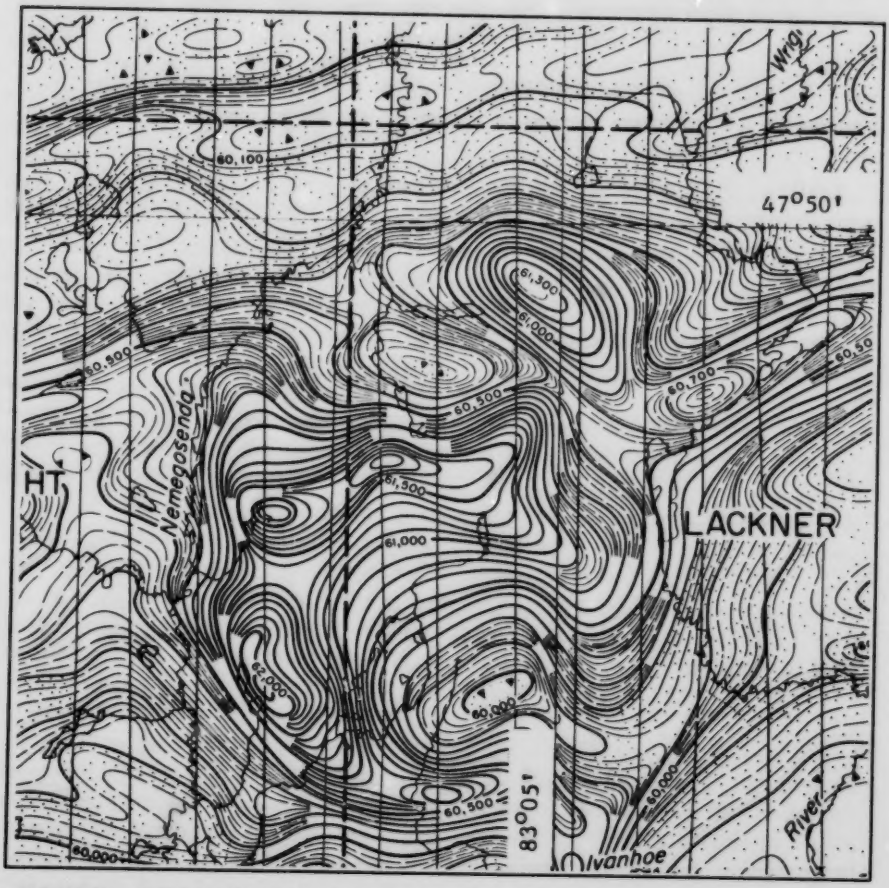

Figure 2. *Aeromagnetic map of the Lackner Lake Alkalic Rock Complex (from Aeromagnetic Map 2232G, ODM–GSC 1963).*

trachytoidal texture, and contain abundant subangular to subrounded mafic xenoliths. The xenoliths are locally derived from the more mafic phases of the complex which are cut by the nepheline syenites. The xenoliths are commonly biotite–rich and indicate that some reaction may have occurred between the inclusions and the syenite magma. Excellent exposures of the syenitic and mafic rocks occur in two canyons in the northeast part of the complex. In the southwest corner, diamond drilling by Multi–Minerals Limited has delineated two dike–like bodies of carbonatite cutting the mafic phases of the complex. These carbonatite bodies host part of the pyrochlore mineralization of Multi–Minerals zone 8. Parsons (1961) reported that carbonatite also occurs as float in the northern part of the complex.

Dikes of magnetite–apatite cut both the mafic and syenitic phases of the complex. Parsons (1961) and Hodder (1961) also reported that the complex is cut by lamprophyre dikes.

On the basis of cross–cutting field relationships, the order of emplacement from oldest to youngest is ijolite–malignite, nepheline syenite, carbonatite, and dike rocks (Table 1). An alternate interpretation of field observations and thin sectioned samples would reverse the order of emplacement of ijolite and nepheline syenite. In this interpretation, nepheline syenite emplacement is followed by ijolite emplacement.

The gneissic country rocks trend northeast and dip steeply. They consist of orthogneiss and paragneiss metamorphosed to the granulite facies rank of regional metamorphism (Thurston *et al.* 1977).

Immediately northeast of the main Lackner Lake intrusion is a small subsidiary complex, the Portage Lake complex (Parsons 1961). This complex has little exposure, is composed entirely of alkalic mafic rocks, and was extensively drilled by Chyka Mines Limited in 1954.

EARLY PRECAMBRIAN (ARCHEAN)

GNEISS

The Lackner Lake complex is enveloped in gneissic rocks of the Kapuskasing Structural Zone, a subprovince of the Superior Province (Thurston *et al.* 1977). The rocks trend northeast, have a steep dip and consist of orthogneisses and paragneisses metamorphosed to the granulite facies rank of regional metamorphism (Thurston *et al.* 1977). Some of the gneissic rocks are thought to be phases of the Shawmere Anorthosite Complex (Thurston *et al.* 1977). During the present survey gneissic wall rocks were not encountered in outcrop and drill core from holes penetrating the gneisses has been lost and is thus unavailable for examination. Hodder (1961) gave a complete description of the gneisses. This description is as follows:

"Gneiss outcrops sporadically on the north and northeast sides of the alkaline complex and is intersected by diamond–drill holes on the Multiwin and Multi–Minerals claims west of Nemegosenda River and on the claims of Ontario Rare Metals to the south of the Multi–Minerals camp. Outcrops to the west and south are totally obscured by sand that covers the area to depths of 50 feet. There is no detailed description of the gneisses in the literature and sparse outcrops preclude a continuous examination of changes in the gneiss towards the outer ring of nepheline syenite. No diamond–drill holes penetrate the gneiss closer than 2,000 feet from the outer ring of nepheline syenite and yet no specimens of gneiss were found that did not carry either a soda amphibole or aegirinaugite.

"In hand specimens the rock is seen to be essentially a biotite–pyroxene gneiss with a strong foliation and a segregation of light and dark minerals into layers. It is medium to coarse

TABLE 1. TABLE OF LITHOLOGIC UNITS FOR THE LACKNER LAKE ALKALIC ROCK COMPLEX.

CENOZOIC

Quaternary

Recent and Pleistocene

Swamp and stream deposits; glacial deposits.

Unconformity

LATE PRECAMBRIAN (PROTEROZOIC)

Lackner Lake Alkalic Rock Complex

Dike rocks

Lamprophyre

Carbonatite

Sovite; silicocarbonatite; magnetite rock; magnetite-apatite rock.

Unfoliated syenitic to ijolitic rocks*

Mesocratic nepheline syenite, commonly porphyritic; mesocratic to melanocratic malignite and ijolite; coarse-grained, mesocratic to leucocratic, inequigranular nepheline syenite to malignite.

Intrusive Contact and Contact Metamorphism

Foliated ijolite, malignite and nepheline syenite†

Melanocratic, pyroxene-rich ijolite to malignite; mesocratic malignite to nepheline syenite; leucocratic nepheline syenite.

Gradational Contact

Massive ijolite, ijolite breccia*

Ijolite breccia with magnetite veins and blebs; ijolite breccia without magnetite; Portage Lake complex.

Intrusive Contact

EARLY TO MIDDLE PRECAMBRIAN

Dike rocks

Diabase.

Intrusive Contact

EARLY PRECAMBRIAN (ARCHEAN)

Gneiss unaffected by fenitization; partly fenitized gneiss.

Notes:
*The order of intrusion of these two units may be reversed.
† This unit may be in part hybrid rocks.

grained with augen of feldspar and quartz up to 1 inch long. Many of these augen are shattered and veined with dark minerals and sulphides. The colour of the gneisses varies from black streaked with white to buff-grey streaked with black. Diamond-drill holes have intersected sections that are mottled white and black and are composed of dark minerals and interstitial calcite. The gneisses are cut by lamprophyre dykes at all localities and by zoned pegmatites with quartz cores on the Multiwin claims. Microscopically their texture is allotriomorphic granular and the essential minerals are alkali feldspar, plagioclase and quartz. Other minerals include aegirinaugite, riebeckite, biotite, calcite, apatite, pyrite, magnetite and zircon. Alkali feldspar is present as coarse grains, commonly perthitic and mostly fractured and veined with dark minerals. Although some grains are fresh, most are altered to a flaky mineral with low birefringence. Alkali feldspar also occurs with albite as fine, ragged grains that have crystallized around the margins of the aegirinaugite or as aggregates of fine grains associated with irregularly shaped biotite, pyroxene, calcite and amphibole. A rim of fine alkali feldspar and albite may be ar-

ranged around the aegirine–augite or between the aegirinaugite and the biotite. These fine grains are not perthitic. In one specimen the alkali feldspar is replaced by a pale green pyroxene that forms a wormy intergrowth. The coarse plagioclase is more often fresh than in the coarse alkali feldspar. Quartz grains may be strained or unstrained and many are rimmed with small grains of aegirinaugite. Undulatory extinction of the strained grains decreases with increasing replacement by pyroxene. The aegirinaugite is paler in the outer margins of these rims around the quartz and is itself rimmed with riebeckite. Aegirinaugite also occurs in masses of small grains in a fine-grained groundmass of feldspar. Many of these small grains of aegirinaugite coalesce to give one big poikilitic grain. The riebeckite appears around aegirinaugite or in clots with aegirinaugite, biotite, feldspar, and calcite. In some specimens it is the dominant dark mineral and is readily recognized under crossed nicols because of the extreme dispersion of its bisectrices. A brown amphibole is seen to be associated with the pyroxene in one thin section. Biotite forms stubby grains, pleochroic for the most part in light browns and yellows and commonly in clusters separated from the aegirinaugite by a rim of fine-grained feldspar. Calcite forms interstitial grains especially in clots of fine-grained pyroxene, feldspar, biotite and riebeckite, and calcite stringers through the rock are bordered by riebeckite. Apatite, zircon, and sphene are accessory minerals."

EARLY TO MIDDLE PRECAMBRIAN

DIKE ROCKS

Work by Parsons (1961) indicated that the gneisses are cut by a north to northwest trending set of diabase dikes. These dikes were not observed during the present survey. Parsons (1961) noted that the dikes did not cut the rocks of the alkalic complex and considered them to be of Matachewan age. If these rocks are Matachewan in age, they are Early Precambrian and older than 2500 Ma (Thurston *et al.* 1977).

LATE PRECAMBRIAN (PROTEROZOIC)
LACKNER LAKE ALKALIC ROCK COMPLEX

The author has retained the lithologic subdivisions of Parsons (1961) but has placed them in a somewhat different order (see Figure 3 and Table 1; cf. Parsons 1961, Map 2008). Parsons (1961) subdivided the mafic suite into four units: ijolite, foliated ijolite, malignite, and syenitic rocks. Parsons (1961) classified the ijolitic rocks separately from the other mafic rocks which were considered by him to be gradational into the syenitic rocks.

In some outcrops the ijolite and malignite appeared to the author to be gradational into each other. Subsequently, precise coding of outcrops and positioning of contacts between these units is difficult.

MASSIVE IJOLITE, IJOLITE BRECCIA

The ijolitic rocks (Unit 3a, 3b) are fine grained, massive and equigranular; they weather black and are black to green–black on fresh surfaces. The best exposures of these rocks are in the western part of the complex. Some of the exposures contain blebs and discontinuous stringers of magnetite. On the weathered surface the ijolites may display a well–developed brecciated appearance with darker weathering angular fragments set in a matrix that weathers a little lighter in colour. Nepheline syenite dikes locally cut the ijolite. The nepheline syenite may contain xenolithic fragments of ijolite as well as the other mafic lithologies (Photo 1). Hodder (1961) reported the presence of clusters of alkali feldspar and nepheline up to 3 mm in diameter in the ijolitic rocks and that the outcrops are cut by nepheline syenite veinlets (Photo 2). The nepheline syenite veinlets are nearly completely altered to cancrinite and zeolites (Hodder (1961).

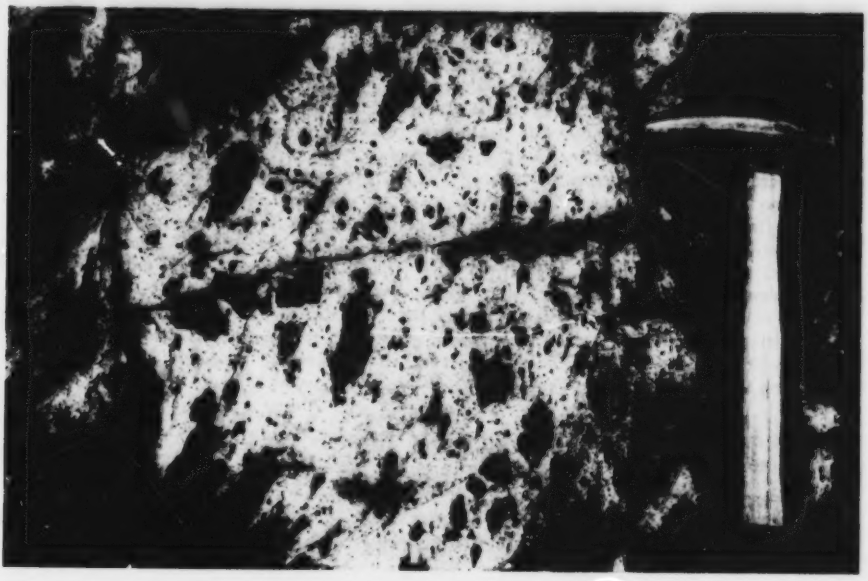

Photo 1. *Angular fragments of ijolite and magnetite in nepheline syenite. North side of Multi-Minerals Limited's zone 6.*

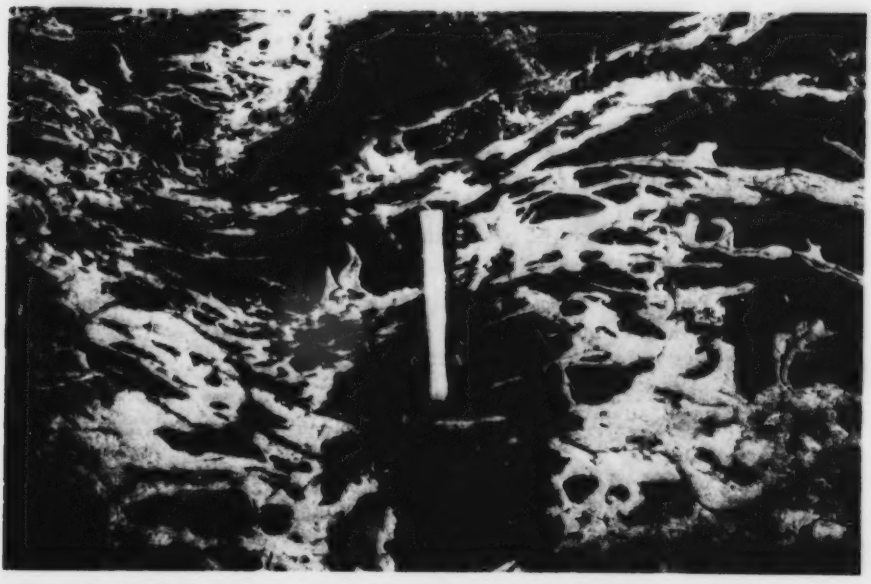

Photo 2. *Nepheline syenite veining ijolite. North side of Multi-Minerals Limited's zone 6.*

In thin section the ijolitic rocks are fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Two thin sections of ijolite have an inequigranular–seriate texture. One sample has a patchy inequigranular–hiatal texture with two contrasting grain sizes.

The estimated mode of the ijolite is clinopyroxene 40 to 50 percent, nepheline 45 to 60 percent, and biotite 0 to 5 percent. Apatite, carbonate, and magnetite are minor accessory minerals, and Hodder (1961) reported that sphene and melanite are also present.

The clinopyroxene is an aegirine–augite which forms anhedral, irregular, coalescing grains with rounded outlines. The pyroxene interlocks with the nepheline. The larger pyroxene grains have cores which are paler green than the rims, implying compositional zonation of the pyroxene grains. Several pyroxene grains contain rounded blebs of nepheline, and in one thin section biotite is poikilitically enclosed in several pyroxene grains. Only one thin section displays euhedral aegirine–augite. Euhedral clinopyroxene crystal faces are present only where the pyroxene grain is in contact with carbonate. Hodder (1961) reported the presence of magnetite, poikilitically enclosed within some of the aegirine–augite.

The nepheline is anhedral, irregular or rounded in outline, and interlocks with other nepheline grains and pyroxene. The nepheline is fresh with only traces of cancrinite and/or sericite alteration. A positive stain for potassium along altered cleavage planes implies the presence of potassium in the alteration product of nepheline. Nepheline poikilitically contains aegirine–augite and apatite.

Biotite is absent or present in minor amounts in most thin sections. It is closely associated with the pyroxene. It is present as brown to red–brown anhedral grains, and has been noted to poikilitically contain aegirine–augite, nepheline, and carbonate. Some of the biotite may be a late–stage alteration of the aegirine–augite.

Hodder (1958, p.12) reported that pyrochlore occurs as separate grains or clusters of grains in ijolite, foliated mafic rocks, and carbonatite. He also reported it to be common as fine–grained disseminations in the magnetite–apatite veins. Pyrochlore also occurs as euhedral crystals in the nepheline syenite stringers that traverse the melanocratic rocks (Hodder 1958, p.12). The pyrochlore is most common as individual octahedra around the margins of aegirine–augite grains (Hodder 1961, p.34). Not uncommonly it occurs as poikilitic inclusions in nepheline, feldspar, biotite, apatite, magnetite or melanite (Hodder 1961, p.34). The author did not observe pyrochlore in the samples examined during this project.

Portage Lake Complex (Ijolite)

No attempt was made by the author to locate the small outcrops of the Portage Lake complex (Unit 3c). Parsons (1961) described this complex as follows:

"A distinctly circular, magnetically anomalous area exists as an outlier to the main Lackner alkaline complex northeast of Hebden (Portage) Lake in Lackner township. This anomalous area is 3,000 feet in diameter.

"In 1954, Chyka Mines Limited made a ground magnetic survey of the area and tested it with twenty–eight diamond–drill holes. The author briefly checked the core and examined a few of the surface exposures.

"The drilling indicates that this magnetically anomalous area is underlain chiefly by ijolite. The ijolite consists of nepheline, pyroxene, and minor amounts of titanite, magnetite, apatite, calcite, and sulphides. In texture it ranges from a fine–grained to a very coarse pegmatitic rock. Its contact with the surrounding gneiss is gradational; pyroxene, nepheline, and minor titanite and calcite have formed in fractures and along the foliation of the contacting gneisses.

"Although the magnetic anomaly is distinctly circular, its internal pattern is extremely erratic, with variously oriented linear, as well as crescent-shaped, anomalies. Drilling indicates that these zones are ijolite partly to completely replaced by biotite, magnetite, and calcite."

FOLIATED IJOLITE, MALIGNITE AND NEPHELINE SYENITE

This lithology (Units 4a,b,c) is highly variable in composition, being gradational into both ijolitic rocks of Unit 3 and syenitic rocks of Unit 5. These rocks form the dominant lithology of the arcuate bands separating the outer nepheline syenites of the rim from the inner nepheline syenites of the core. The variability in the relative proportions of the various minerals found in closely spaced samples has resulted in a broad generalization in rock coding of this lithology and prevented meaningful subdivision into more clearly defined lithologic units. Ijolite (Unit 4a), malignite (Unit 4b) and nepheline syenite (Unit 4c) are complexly intermixed. The best exposures of these rocks are found in the southwest and northeast parts of the complex. To avoid repetition of descriptive data, the rocks of this grouping will be discussed together. The distribution of this rock unit is largely interpreted from diamond drilling and magnetic data (Hodder 1961; Parsons 1961).

On outcrop, these rocks are fine to medium grained, and weather black, green–black, mottled pink and black, and pink. On fresh surface the colours are similar but of a darker hue. The foliations of these rocks are of two types. One type is due to the preferred orientation of biotite and may be properly classified as a schistosity. The other is due to variations in the relative mineral percentages and is thus a primary banding. Near contacts with the syenitic rocks, some of the alkali feldspars are tabular. The subparallel orientation of these feldspars may impart a trachytoidal foliation to the rock. Schlieren and elongated mafic xenoliths in the contact syenites also impart a banding or gneissosity to the rock. The contact of the ijolites and nepheline syenites with the malignitic rocks appears gradational. The presence of mafic xenoliths of ijolite and malignite in the nepheline syenites close to the contact indicates that the mafic rocks are older than the nepheline syenites.

In thin section, the rocks are fine to medium grained, massive, equigranular to inequigranular–seriate, allotriomorphic with curved to straight grain boundaries. Rarely, there are sufficient grains with euhedral outlines to classify the rock as hypidiomorphic. In one thin section, nepheline and perthite form anhedral or subhedral phenocrysts in estimated amounts of 15 to 20 percent. A porphyritic texture is more apparent on the weathered outcrop surface of the syenitic phases than in thin section.

Within the malignitic to ijolitic phases close to the syenitic contact, granoblastic to granoblastic elongate textures are present. The best development of contact metamorphic textures appears to be in those rocks located close to the above contact. The mafic, ijolitic to malignitic rocks may have been hornfelsed by the intruding nepheline syenite magma. The author has examined numerous suites of alkalic rocks and this is the first occurrence of recognizable contact metamorphic textures. Hodder (1961) also recognized the development of the metamorphic texture within this unit.

Another microscopic textural feature which also appears unique to the Lackner Lake complex is the ubiquitous presence of circular to elliptical zones of inclusions within the larger feldspar and nepheline grains. The inclusions consist of round blebs of aegirine–augite, and round to round–elongate blebs of apatite. The inclusions display no systematic variation in size or type across the inclusion zone. Extinction of the porphyroblastic grains may cross the zone of inclusions. A

sufficient number of porphyroblastic grains do display slight variations in extinction across the inclusion zone to imply that compositional change does occur across the inclusion zones. On the basis of his measurements, Hodder (1961) suggested that the rims of the feldspar porphyroblasts may be more sodic than the cores.

In thin section these rocks are estimated to contain 10 to 45 percent aegirine–augite, 10 to 50 percent nepheline, 0 to 20 percent biotite, and 0 to 60 percent perthite. Red–brown garnet in amounts of 5 to 15 percent is present in three thin sections, magnetite in amounts up to 5 percent in several sections, and apatite is present in nearly all thin sections in amount varying from trace to 1 percent.

Orthoclase, albite, olivine (altered), cancrinite, carbonate, sphene, and chlorite are present in one or more thin sections. Hodder (1961) also reported that fluorite, sodalite, wollastonite, zircon, pyrochlore, and white mica occur within this rock suite.

The aegirine–augite forms anhedral to subhedral grains with a green pleochroism. The grains are generally anhedral and round in outline. Biotite, apatite, magnetite, carbonate, and nepheline have all been observed to be poikilitically enclosed within the pyroxene. The larger grains may have pale green cores, implying compositional variation within individual grains. The rims of the grains are likely richer in sodium and iron than the cores.

Nepheline is generally fresh in appearance and anhedral in outline. Minor cancrinite and/or sericite alteration occurs along the cleavage planes and rims of some grains. Potassium staining indicates that altered areas contain potassium. Circular zones of inclusions consisting of round blebs of pyroxene and apatite occur in larger grains and variations in extinction across this zone of inclusions implies that the larger grains are compositionally zoned. Magnetite is rarely poikilitically enclosed in nepheline.

Biotite forms brown to red–brown, euhedral to subhedral grains in close association with the other mafic minerals, pyroxene and garnet. The biotite grains are often subparallel in orientation and impart a schistosity to the rock. Apatite, aegirine–augite, and magnetite occur as poikilitic inclusions in biotite. Biotite consisting of grains with ragged outlines is present in one thin section and occurs as aggregates enclosing pyroxene in a second.

Perthite forms anhedral grains interlocked with pyroxene and nepheline. The perthite in a few places partially encloses nepheline. The perthite has a very well developed stringy perthite texture. In several thin sections, the perthitic nature of the feldspar is visible at only the highest magnification. The exsolved plagioclase is oriented normal to the long axis of the feldspar grains and Carlsbad twin planes. The larger perthite grains have circular to elliptical zones of inclusions consisting of round blebs of pyroxene and round to round–elongate blebs of apatite. Several perthite grains also contain round blebs of nepheline, but nepheline is rare as part of the inclusion zone within perthite. As with nepheline, the smaller perthite grains lack circular zones of inclusions. Variation in extinction across the inclusion zones implies compositional variation across the zone. The author has noted grains which have a perthitic core enclosed by the inclusion zone, followed by a non–perthitic rim. The reverse order was also noted.

Garnet is not common in this lithologic unit but where present, it is generally present in fairly noticeable amounts. The garnet is a brown, yellow–brown, to yellow melanite (?) of anhedral form occurring in close association with pyroxene

and biotite. Rocks containing garnet are generally tough to break, dense, and somewhat more vitreous in lustre on the freshly broken surface.

Magnetite is present as anhedral, irregular, disseminated grains. The magnetite occurs in composite clots in several thin sections.

Apatite is ubiquitous in very minor trace amounts as anhedral to euhedral grains.

The foliated syenites (Unit 4c) are gradational into the more massive nepheline syenites (Unit 5) of the rim and core of the complex.

UNFOLIATED SYENITIC TO IJOLITIC ROCKS

Parsons (1961) subdivided the unfoliated syenitic to ijolitic rocks into three groupings. The various groupings are gradational into each other and were considered by him to be different textural and compositional phases of the same magma. The author considers the rocks to be the product of two distinctly different magmas and that a considerable amount of hybridization has taken place.

Mesocratic Nepheline Syenite

A fine–grained, mesocratic, commonly porphyritic, nepheline syenite (Unit 5a) occurs in close proximity to the interpreted contact between the foliated ijolitic, malignitic and syenitic rocks and the coarser–grained nepheline syenites of the core and rim. This phase appears to be, at least locally, gradational into the foliated nepheline syenites (Unit 4c).

Where the potassium feldspars are tabular, they commonly are weakly oriented subparallel to each other thus imparting a trachytoidal texture to the rock. Phenocrysts, which may exceed 1 cm in length, are oriented subparallel to each other and occur in a seriate distribution. Phenocrysts generally constitute no more than 20 to 30 percent of the rock.

The fine–grained, commonly porphyritic, nepheline syenite is commonly xenolithic and exhibits local development of schlieren. The xenoliths are elongated in the plane of foliation of the rock. The elongated xenoliths along with either, or both, banding due to variation in relative mineral content or trachytoidal texture due to the subparallel orientation of tabular feldspar crystals, define the foliation. Some xenoliths display no reaction rim development in contact with the nepheline syenite and others display the development of a dark selvage of biotite and pyroxene (?) which may approach 0.5 cm in width. Some of the xenoliths are composed of ijolite or malignite and are clearly derived from the more mafic phases of the foliated units (Unit 4). Other clasts of biotite, and biotite–pyroxene are coarser grained than those that are more clearly derived from the foliated units. They probably represent altered and recrystallized clasts of ijolite and malignite. Xenoliths generally are 20 cm or less in long dimension, and locally may be abundant, making up an estimated 5 percent of the rock.

Some of the schlieren have been plastically deformed and have been partially absorbed such that the mafic resistates have remained and have been strung out into wispy streaks. In other cases the schlieren may have formed by flow segregation of the mafic constituents during emplacement. The variation in mafic content across an outcrop surface imparts a banded or gneissic appearance to any given exposure.

The rocks of this unit weather pink, mottled pink and black, or grey–pink and have the same colours on fresh surfaces. The weathering out of the nepheline

leaves a pitted rough surface to the rock. In thin section the rock is fine to medium grained, massive, equigranular to inequigranular–porphyritic–seriate, allotriomorphic to hypidiomorphic. Grain boundaries tend to be curved to straight.

Modally the rock is estimated to contain 20 to 40 percent nepheline, 30 to 45 percent perthite, 10 to 45 percent aegirine–augite, and 0 to 20 percent biotite. Apatite is common in all thin sections in amounts of less than 1 percent. Cancrinite, magnetite, carbonate, plagioclase (An7–10), amphibole, and pseudoleucite are present in one or more thin sections. The pseudoleucite was noted in only one thin section where it occurs as vermicular intergrowths of nepheline and potassium feldspar. Hodder (1961) reported sphene, sodalite, zircon, perovskite, and pyrochlore to be present.

Aegirine–augite forms coalescing pleochroic green grains with rounded outline. The larger grains locally display dark green rims and pale green cores, implying compositional zoning. Apatite, biotite, nepheline, and carbonate are poikilitically enclosed. Dark green–brown pleochroic amphibole mantles and replaces pyroxene in one thin section.

Perthite forms anhedral, irregular grains interlocked with nepheline and pyroxene. The perthite is of the string type, and the alternating plagioclase–potassium feldspar bands are oriented normal to the long axis of the grain boundaries. The larger grains display Carlsbad twinning. One thin section displays patch perthite (antiperthite), interpreted by the author to have resulted from replacement of albite by potassium feldspar. Larger perthite grains may display circular rings of inclusions consisting of round blebs of apatite and aegirine–augite; one ring of inclusions may contain several blebs of nepheline. Slight variations in extinction across this zone of inclusions implies compositional differences between the core of the perthite grain enclosed by the ring of inclusions and the perthite rim lying outside the ring of inclusions. One perthite grain has a perthitic core and a non–perthitic rim (orthoclase) separated by the zone of inclusions. There is no variation in mineralogy or size of the inclusions across the zone and the zones are roughly equidistant from the margin of the host perthite. Some inclusion zones outline former crystal shapes implying that the feldspar lying outside the ring of inclusions has overgrown a previously existing crystal entrapping the pyroxene and apatite grains to form the ring. The round mineral grains forming the ring of inclusions within the feldspar grains display a random orientation.

Nepheline is fresh and interlocks with the pyroxene and perthite grains. The nepheline poikilitically encloses aegirine–augite, apatite, and rarely potassium feldspar. One nepheline grain appears to poikilitically enclose nepheline of a different crystallographic orientation. The nepheline displays incipient alteration to cancrinite and/or sericite along grain boundaries and cleavage directions. Altered areas of the nepheline take a good stain for potassium.

Biotite is anhedral to euhedral in form and brown to red–brown in colour. The biotite is closely associated with the pyroxene and has been observed to poikilitically enclose pyroxene and apatite. One section contains biotite partially enclosing nepheline and with bent (001) cleavage planes. In another section some magnetite grains display narrow rims of biotite suggesting the development of a reaction rim of biotite, probably in response to reaction with late–stage fluids derived from the crystallizing nepheline syenite magma.

Mesocratic to Melanocratic Malignite and Ijolite

Malignite and ijolite (Unit 5b) are more equigranular, coarser–grained, and homogeneous than the mesocratic nepheline syenite (Unit 5a) and more mafic than

the coarse–grained, inequigranular, leucocratic nepheline syenite (Unit 5c). The colour index varies from 30 to 45 and the rocks vary in composition from ijolite to nepheline syenite. Foliation is weak to absent. Contact relationships with the leucocratic nepheline syenite (Unit 5a) and the coarse–grained, inequigranular, leucocratic nepheline syenite (Unit 5c) were not observed.

The rock weathers pink to mottled pink and black, grey and black. Fresh surfaces show similar colours. The weathered surface is pitted from the weathering of the nepheline leaving the feldspar and mafic minerals standing in relief. This lithology occurs in the northeast, northwest and southwest parts of the complex.

In thin section, the rock displays a dominantly medium–grained, massive, equigranular, hypidiomorphic texture. Several thin sections have an allotriomorphic texture with straight to curved grain boundaries.

The mode is estimated to be 25 to 45 percent nepheline, 5 to 50 percent perthite, 5 to 20 percent biotite, and 0 to 45 percent aegirine–augite. Two thin sections contain in excess of 10 percent amphibole. Trace to minor amounts of amphibole, pyrochlore, and albite are present. Hodder (1961) reported the presence in trace amounts of zircon, sodalite, and fluorite in this unit.

Biotite forms brown, anhedral grains in close association with pyroxene. The mineral may have ragged edges and it also occurs intergranular to the feldspar and nepheline. Biotite has been noted to poikilitically enclose nepheline and pyroxene, and form narrow rims on magnetite grains.

Nepheline is anhedral to subhedral, fresh in appearance and only locally altered to cancrinite and/or sericite. The nepheline forms round grains interlocked with pyroxene and feldspar.

Aegirine–augite pyroxene forms anhedral to subhedral grains; the larger of these have pale green cores implying compositional zonation. Apatite, and rarely, biotite are poikilitically enclosed in the pyroxene. Locally green to brown–green amphibole mantles and replaces the pyroxene.

Perthite forms anhedral grains; larger grains are Carlsbad–twinned. The perthite is a stringy type, with the alternating plagioclase and potassium feldspar bands oriented normal to the long axis of the feldspar grain. Samples of this lithology that approach ijolite in composition contain orthoclase.

Amphibole is pleochroic from green to green–brown, and is likely enriched in sodium and iron. Relict pyroxene cores in some amphibole grains indicate that some of the amphibole formed by replacement of pyroxene.

Mesocratic to Leucocratic Nepheline Syenite to Malignite

Medium– to coarse–grained, inequigranular, mesocratic to leucocratic, nepheline syenite (Unit 5c) is best exposed in the southwest part of the complex. Scattered exposures are also present in the northeast corner of the body. This rock type is generally much more leucocratic and coarse grained than the rocks of Unit 5b. It rarely has a mafic index of more than 20 in the southwest corner but in the northeast corner the index locally exceeds 40. It is texturally more homogeneous than the fine–grained nepheline syenite (Unit 5a) and generally lacks foliation of any type although a weak trachytoidal texture may locally be present. Texturally or compositionally there is no detectable difference between samples of this rock unit located outside the arcuate ring of the foliated ijolitic, malignite, and syenitic rocks of unit 4, and those samples located in the core of the complex. This nepheline syenite unit (Unit 5c) cuts the foliated rock units (Unit 4).

The rock weathers grey, pink, pink–grey and may be flecked with black mafic minerals. The weathered surface is pitted from the weathering out of the nepheline and weathering may be so extensive as to reduce the outcrop to gruss consisting of disaggregated feldspar, biotite, and amphibole grains. Weathering makes surface sampling difficult.

In thin section the rock is commonly medium to coarse grained, massive, equigranular, hypidiomorphic. Rarely, it is allotriomorphic with curved to straight grain boundaries.

The mode is estimated to be 15 to 45 percent nepheline, 20 to 70 percent perthite, trace to 15 percent biotite, and 0 to 45 percent aegirine–augite. In a number of sections amphibole is present in amounts varying from 5 to 15 percent, and in several sections albite (An4–8) is present. Cancrinite, magnetite, carbonate, olivine, sodalite, pyrochlore, sericite and sphene occur in trace to minor amounts. Compositionally the rock varies from nepheline syenite to malignite.

The nepheline occurs in fresh anhedral to euhedral crystals. The more mafic phases tend to have anhedral nepheline and the more leucocratic phases tend to have euhedral nepheline. The nepheline may be altered along the periphery of the grain and along cleavage cracks to cancrinite and possibly sericite. The altered areas take a positive stain for potassium.

Perthite is anhedral in form and interlocks with the nepheline and pyroxene. The perthite is interstitial to the nepheline and pyroxene and contains round poikilitic inclusions of nepheline and more rarely pyroxene. The perthite has a string texture with the alternating plagioclase and potassium feldspar lamellae oriented normal to the long axis of the grain. Carlsbad twinning is common in the larger grains. Two thin sections contain tabular, subhedral orthoclase rather than perthite.

Biotite forms brown to red–brown grains in close association with pyroxene. It may also occur as discrete grains which are intergranular to feldspar and nepheline. The biotite poikilitically encloses aegirine–augite and apatite, and occasionally partially encloses nepheline. One thin section contains biotite with bent (001) cleavage planes.

The pyroxene is an anhedral to subhedral aegirine–augite. It poikilitically contains apatite, rarely biotite and more rarely nepheline. Some of the larger grains have cores paler green than rims, implying compositional zonation to a more aegirine–rich rim. The pyroxene may form round to subrounded grains thickly mantled with amphibole and undoubtedly has undergone replacement by the amphibole. The author interprets the alteration of the clinopyroxene to amphibole as the result of deuteric reaction with late–stage fluids in the crystallizing nepheline syenite magma.

Albite (An4–8) occurs in two thin sections and has undergone patchy replacement by potassium feldspar. The albite content is generally minor and individual grains are situated interstitial to nepheline and other feldspar.

Amphibole is deeply pleochroic from green to green–brown, and is present in about half the thin sections prepared from rocks of this lithology (Unit 5c). The amphibole is anhedral in form, and interlocks with and is closely associated with the pyroxene which it has often replaced. Pyroxene relicts are common in the larger amphibole grains. The colour of the amphibole suggests it is a high sodium– and iron–bearing variety.

Other Unfoliated Syenitic Rocks

Hodder (1961) used the term 'alkorthosite' for a predominantly alkali feldspar rock from the Lackner Lake complex. The alkorthosite of Hodder (1961) appears to be identical to perthosite (AGI 1972, p.531), which is defined as "a light colored syenite composed almost entirely of perthite, with less than three percent mafic minerals". This rock type was not observed by members of this field party and was described by Hodder (1961) as follows:

> "The alkorthosites are white to grey rocks composed mostly of alkali feldspar with nepheline and a very minor amount of biotite, aegirine- augite, apatite, magnetite, calcite, cancrinite, melanite and albite. These rocks outcrop within the layer of malignites north of Tower Lake, near the contact between equigranular nepheline syenite and malignite, and have been observed in drill-cores from just north of the Multi-Minerals camp. They grade into foliated malignites with the increase in the content of dark minerals and nepheline; their texture is hornfelsic. Nepheline is subhedral to anhedral and fresh except for minor cancrinite. Perthitic alkali feldspar is in stubby laths that have microcline twinning, show an alignment with respect to one another, and are rimmed with multiple-twinned albite which appears to have exsolved from perthite. Albite may occur as individual grains. The pyroxene is very irregular in grain outline and in grain size, and fine-grained magnetite is dusted through the rock. Calcite is interstitial."

Pseudoleucite nepheline syenite (Photo 3) is a noticeable and unusual variety of nepheline syenite, noted along the south contact of the magnetite-apatite vein that forms the No. 6 zone. This syenite consists of rounded to elliptical clots of grey to buff nepheline plus alkali feldspar. These clots have been studied by microprobe and were interpreted by Watkinson (1973) as being pseudoleucite. Hodder (1961) reported similar syenite occurring at the McVittie pit as well as in proximity to the No. 6 ore zone. In the occurrences sampled by Hodder (1961) this syenite type lies adjacent to a magnetite vein. A section across the vein and host rock shows: magnetite vein, pyroxene selvage, clotty nepheline-feldspar syenite (psuedoleucite nepheline syenite) and normal nepheline syenite. While

Photo 3. ***Pseudoleucite crystals in nepheline syenite. South side of Multi-Minerals Limited's zone 6.***

TABLE 2. AVERAGE ELECTRON MICROPROBE ANALYSES OF PSEUDOLEUCITE AND CONSTITUENT NEPHELINE AND FELDSPAR, LACKNER LAKE ALKALIC ROCK COMPLEX. (FROM WATKINSON 1973).

	1	2	3	4	5
SiO_2	54.57	43.67	43.57	63.59	63.92
Al_2O_3	23.14	33.05	33.30	18.25	18.08
Na_2O	5.03	15.80	15.60	1.17	1.50
K_2O	14.39	6.68	6.52	15.85	14.62
Total	99.34	99.20	98.99	98.86	98.12

1. Pseudoleucite from Lackner Lake malignite LL007.
2. Nepheline in groundmass LL007.
3. Nepheline in pseudoleucite LL007.
4. Feldspar in groundmass LL007.
5. Feldspar in pseudoleucite LL007.

Hodder (1961, p.20, Plate IV) illustrated this zonation very well, the site of the vein studied by him was not located by the author.

On the weathered outcrop the rounded to elliptical clots are up to 4 by 2 cm in maximum dimension. These mafic–poor, buff to grey clots are set in a fine–grained, dark grey to green–grey matrix. Elongation of the clots tends to parallel the long axis of the associated magnetite vein. Some of the more circular clots have a weak trapezohedral outline that suggests the crystal form of former leucite. The larger clots also contain aggregates of mafic minerals in their cores suggesting that the pseudoleucite crystals may have nucleated around earlier crystallizing clinopyroxene. Smaller clots not displaying the mafic aggregates in their core may have resulted from the diamond saw passing through the outer rim of the crystal rather than its core.

In thin section the nepheline and alkali feldspar clots form an interlocking mosaic of anhedral grains. The feldspar is orthoclase and the texture is granoblastic with curved grain boundaries. Mafic cores are composed of aegirine–augite and biotite, which are anhedral to subhedral in form and interlock with each other. The grain size of the clots is one or two orders of magnitude larger than the matrix and the grain size of the clots is hiatal with the matrix.

The matrix consists of aegirine–augite, nepheline and alkali feldspar. The pyroxene is anhedral and interlocks with the nepheline and feldspar. The pyroxene, alkali feldspar, and nepheline occur in roughly equal proportions within the matrix.

The matrix contains microphenocrysts of orthoclase. These crystals display Carlsbad twinning and may poikilitically contain anhedral, rounded inclusions of aegirine–augite along their perimeters. One relatively large anhedral grain of aegirine–augite displays a pale green core and abundant, poikilitically enclosed, rounded blebs of nepheline and potassium feldspar. The matrix of the pseudoleucite clots has a subtle granoblastic elongate texture that flows around the coarser–grained blebs of nepheline and potassium feldspar. Watkinson (1973) presented microprobe analyses of nepheline and feldspar comprising pseudoleucite; his analyses are given in Table 2.

CARBONATITE

Carbonatite (Unit 6) is not exposed in outcrop at the Lackner Lake complex but was encountered in diamond drill holes in Multi–Minerals Limited zone No. 8. Parsons (1961) also indicated its presence in the northern part of the complex

but these exposures were not relocated by members of this field party. The diamond drill core from this carbonatite zone has been lost and the author must rely on previous descriptions and some carbonatite drill core salvaged from a collapsed core shack on the property of Multi-Minerals Limited. The location of the drill hole from which the core was recovered is unknown. The carbonatite as indicated by Parsons (1961) forms dike-like bodies in close association with foliated ijolite and malignite (Unit 4).

Hodder (1961) described the carbonate rocks as follows:

"Only two outcrops of carbonate rock are known in the area. One of these lies within malignites 200 yards east of Rock Lake, and the other is on the property of Dominion Gulf at the east side of the alkaline complex. However, a body of carbonate rock 650 feet long and 50 feet wide and proven to a depth of 500 feet has been outlined by diamond drilling on the Multi-Minerals property north of Camp Lake.

"The outcrop at Rock Lake is of a dense grey rock, composed of approximately 20 percent coarse- to fine-grained carbonate, 15 percent poikilitic alkali feldspar, 20 percent fine-grained nepheline, 15 percent magnetite, and accessory amounts of melanite, aegirine-augite, pyrochlore and biotite. The rock is surrounded by nepheline syenite. The carbonate body outlined by diamond drilling is lenticular in plan and cross-section. It is enclosed principally within malignites but in drill holes it has been observed to intersect ijolite and nepheline syenite. The contacts of the main mass with the wall rocks are sharp. The wall rock has patches of calcite and the biotite and pyroxene content of the malignite is highest within 2 feet of the malignite-carbonate rock contact. The foliation in the malignite is not distinct about the carbonate body. Narrow veinlets of calcite penetrate the enclosing rock beyond the margin of the main mass. The calcite includes angular fragments of rock that are noticeable along the large diameter core as pink to grey patches from a few centimetres to several inches long. The appearance of the fragments corresponds most closely to that of equigranular nepheline syenite. They are now fine grained masses of recrystallized feldspar in rosettes and anhedral grains of nepheline. Irregular grains of aegirine-augite replace the feldspar, and magnetite in turn replaces the aegirine-augite. Calcite is dispersed through the inclusions. The rims of the inclusions are marked by borders of coarse aegirinaugite and biotite, and sometimes by a murky brown alteration. The pyroxene appears to have replaced the biotite and the murky brown alteration. The calcite content of the lenticular body varies; in places bands of aegirinaugite, apatite, magnetite, biotite, sulphides, pyrochlore, albite and alkali feldspar that conform with the walls of the body account for 40 percent of the rock; elsewhere specimens consist of almost pure white or pink calcite. The calcite grains are very coarse and show no signs of deformation."

The author has observed pieces of carbonatite core with subangular to subrounded inclusions of fine-grained ijolite to malignite. These inclusions commonly have dark, fine-grained micaceous selvages which may exceed 0.5 cm in width.

The author prepared thin sections from carbonatite core salvaged in 1970. Carbonate forms 80 percent of the rock as an interlocking mosaic of grains. The carbonate is fresh and unsheared and likely formed rather late in the magmatic history of the complex. Apatite is present as rounded, vitreous, anhedral, green grains. Magnetite is anhedral to subhedral in form and biotite is subhedral to euhedral. Aegirine-augite is common and occurs as anhedral to subhedral grains poikilitically enclosing apatite and carbonate. Pyrochlore is present as euhedral, red-brown, zoned crystals. The pyrochlore occurs along the rims of magnetite grains and as isolated grains in the carbonate matrix. The isolated grains of pyrochlore may display a set of cracks radiating out from the grain into the carbonate.

Magnetite and Magnetite-Apatite Veins

Magnetite and magnetite-apatite veins are common in the southern half of the complex. They were the first geologic features examined by prospectors working on the complex. They are present at McVittie pit, and compose the No. 6 ore

zone of Multi-Minerals Limited, and are likely also represented by the small magnetite-apatite zones drilled by Falconbridge Nickel Mines Limited in the southeast part of the complex. The author has observed dikes or veins of this rock type cutting Unit 3 (ijolite and ijolite breccia), Unit 4 (foliated ijolite, malignite and nepheline syenite), and Unit 5 (unfoliated nepheline syenite, malignite, and ijolite). Their presence affects the compass moderately to strongly.

Selvages, developed next to the magnetite and magnetite-apatite veins, have been described by Hodder (1961). Since outcrops were better exposed and diamond drill core was available for examination at the time he completed his work on the complex, his description of the selvages is repeated here:

"In the exposures flanking Beaver Pond (near zone 6), veins of magnetite cut the nepheline syenite and the wall rock alongside these veins is enriched in aegirine-augite. These basic selvages contain blebs of nepheline and alkali feldspar and correspond very closely in composition and texture to ijolites of the McVittie pit. A sequence away from the centre of a magnetite vein is as follows: 1, magnetite of the vein; 2, ijolite composed of nepheline, aegirine-augite, magnetite and biotite; 3, an ijolite with blebs of feldspar and nepheline. With increasing amount of the light coloured blebs the ijolite grades into homogeneous nepheline syenite. The width of the pyroxene margin is directly proportional to the width of the magnetite vein and is two to three times wider than the vein. In a thin section of a magnetite vein half an inch wide nepheline is seen to be the dominant light coloured mineral next to the magnetite vein, although feldspar occurs in minor amounts. The nepheline is fresh and euhedral to subhedral. Small grains of aegirine-augite coalesce into larger grains and appear to replace the nepheline, but there are euhedral nepheline grains in contact with aegirine-augite. Biotite may be present between the magnetite and aegirine-augite grains and the magnetite vein may have a thin core of alkali feldspar. Thin section examination of the rocks with feldspar-nepheline blebs farther away from the magnetite vein shows that the blebs are round patches of close-packed feldspar and nepheline grains with minor aegirine-augite, biotite, magnetite and calcite. The blebs are set in a fine-grained hornfelsic groundmass composed of nepheline, some alkali feldspar in fine equant grains and medium-sized laths, and an abundance of fine aegirine-augite. The edges of the blebs mark the limit of the pyroxene and of the larger grains of nepheline and feldspar. Pyrochlore grains are present in a number of these blebs."

Hodder (1961 p.53-54) described the veins as follows:

"The magnetite-apatite bodies at Nemegos are pod-shaped and lie within malignite. The walls of the bodies are vertical or dip steeply and the strike of the contacts and foliation conforms roughly to that of the foliation in the malignite. Blocks of malignite are included within the orebodies and bear no evidence of alteration. Unaltered nepheline syenite is also present within magnetite-apatite but whether it is intrusive into the magnetite-apatite or included within it, is not clear. The minerals of these orebodies, magnetite, apatite, sulphides, pyrochlore, aegerinaguite, are also common to ijolite, malignite and carbonate rock and to the metasomatized gneiss outside the nepheline syenite."

Hodder (1961) proposed that the magnetite and magnetite-apatite veins were emplaced into cone sheet fractures or breccia zones. The No. 6 ore zone as indicated by Parsons (1961) forms neither a cone sheet nor radial fracture filling. Some of the dikes observed by the author have the appearance of breccia cemented with magnetite and magnetite-apatite.

Slab and polished samples of the magnetite-apatite mineralization at Multi-Minerals Limited zone No. 6 show angular fragments of ijolite and massive conchoidally fractured magnetite, set in a groundmass of granular magnetite and vitreous green apatite. The veins appear to occupy fractures which have undergone at least two periods of magnetite mineralization and one period of apatite mineralization. Fracturing of the first-formed magnetite occurred before the second period of mineralization.

DIKE ROCKS

Dike rocks (Unit 7) were not encountered in the present survey but have been reported by Hodder (1961) and Parsons (1961). The observations of Hodder (1961) are as follows:

"Lamprophyre dykes do not outcrop but dykes from a few inches to 20 feet thick are cut by diamond-drill holes. The dykes strike conformably with the circular nature of the alkaline complex and dip at angles of 15 to 20 degrees away from the centre of the complex. They cut all alkaline rocks and intrude the enclosing gneisses. The rock is fine-grained, inequigranular to equigranular, and dark grey spotted with white patches as much as 3 mm wide. The white patches are clots of calcite or calcite with plagioclase and alkali feldspar, in a matrix consisting of euhedral colourless pyroxene grains, an altered alkali feldspar, albite, dark brown biotite, magnetite, calcite, chlorite and zeolite. The pyroxene is altered to chlorite. The albite is unaltered, but the alkali feldspar grains are generally altered to a flaky mineral with high birefringence. However, they may be fresh, and younger alkali feldspar may have crystallized along grain boundaries and cracks. Fine magnetite is dusted through the rock and forms wormy intergrowths in the altered pyroxene. Single grains of calcite are crowded between other grains or are collected together in the clots that fleck the rock.

The significance of the lamprophyre dikes was interpreted by Hodder (1961) as follows:

"At Nemegos, lamprophyre dykes occupy ring-dyke fractures that dip at low angles away from the centre of the complex. They are the youngest rocks in the area. The principal minerals are a colourless pyroxene, albite, alkali feldspar, biotite, magnetite, and calcite. The larger grains are cracked. It is concluded that the dykes formed by the crystallization of a residual magma in flat-lying ring-type fractures that formed when the roof of the magma chamber collapsed after the last major intrusion."

Additional observations by Parsons (1961) are as follows:

"Dark, fine-grained dikes are found throughout the area, cutting both the alkaline and gneissic rocks, but are possibly more prevalent in the latter. Their composition is indicated, by a number of thin sections, to be variable; usually the major constituents are pyroxene, biotite, feldspar, and calcite, with occasional fresh olivine. The accessory and secondary minerals include magnetite, apatite, scapolite, sodic amphibole, chlorite, etc.

"One of these dikes, traced by drilling on the Multi-Minerals property, appeared to be a thin sheet-like mass dipping gently outwards. A similar trend was noted for a dike at surface on the former Dominion Gulf Company property on the east flank. This dike has abundant angular fragments of coarse leucocratic nepheline syenite, as well as definite fragments of a quartz-bearing gneiss. This would indicate that the material had moved from the gneiss through the outer coarse nepheline syenite ring. A ring-like feeder source in the gneiss is indicated for these near-flat dikes. Some drill holes show many of them to be present, confirming the view that most of them may be nearly-flat lying."

PETROLOGY

The petrogenesis of the complex is complicated and will require much additional work beyond the scope of the present survey. The present survey was inhibited by the fact that nearly all diamond drill core from the complex has been lost. This largely restricted sampling to the limited number of surface outcrops. The rocks are commonly heterogeneous and xenolithic and/or gneissic in appearance. Sampling was done with care to obtain homogeneous fresh rocks suitable for chemical analysis. Samples which the author would have rejected for analysis at other complexes were included in the Lackner Lake suite in hopes of obtaining a broader data base for comparative purposes. The presence of schlieren, plastically deformed xenolithic fragments, and reaction rims on xenoliths within the mesocratic nepheline syenite (Unit 5a) in proximity to the foliated ijolite, malignite and syenite (Unit 4) are indicative of local assimilation and hybridization. It is not likely that large volumes of the foliated units were absorbed by the intruding

syenite magma that represents a lower-temperature petrologically more evolved phase. Field observations indicate, however, that interaction between these units has taken place. To what extent this interaction modified original melt compositions in proximity to the contacts between these units (Units 4 and 5) is difficult to evaluate. Analyses of samples taken in close proximity to this contact likely represent hybrid compositions. The apparently gradational nature of the contact between the foliated syenite and leucocratic nepheline syenite (Units 4c, 5a) could conceivably be the result of chemical interaction between them, producing hybrid rock compositions.

Normative calculations (Table A-4, Appendix A) using the method of Irvine and Baragar (1971) were completed for the purpose of comparison with other alkalic rock complexes. The Irvine and Baragar (1971) system cannot adequately treat carbon dioxide as a magmatic phase so the norms using the method proposed by LeBas (1973) were also calculated (Table A-5, Appendix A). The LeBas (1973) norms are perhaps the more realistic ones for alkalic rocks. The norms can only be used for comparative purposes because of the hybrid nature of many of the rocks.

Average compositions of the lithologic units are given in Table A-6 (Appendix A). The statistics indicate a generally higher degree of variability than observed in other alkalic complexes. This variability is likely a function of the suggested hybrid nature of most of the rocks found in this sample suite.

Petrogenetic Model 1

The petrogenesis of the Lackner Lake complex was studied in detail by Hodder (1961). Condensed versions of some of his conclusions are as follows:

1. The magnetite-apatite bodies formed from aqueous solutions rich in lime, iron, components of the accessory minerals and some CO_2. Magnetite-ilmenite intergrowths indicate a temperature of 700°C. The magnetite-apatite bodies are intrusive rocks occupying cone-sheet fractures.
2. The carbonatite was emplaced by a hydrothermal solution rich in lime, and containing phosphorous, sulphur, niobium and copper genetically related to the alkaline intrusions. The hydrothermal solution was derived by fractionation from a parent nepheline syenite magma.
3. The ijolites are products of pyroxenization of nepheline syenite along the flanks of magnetite veins. Similar metasomatizing fluids also produced the malignite.
4. The association of carbonatites and ijolites is a function of the alteration of the nepheline syenite to more basic alkaline rock through the introduction of aqueous carbonate solutions.
5. The malignite is produced by metasomatism of a sheet of regional gneiss caught between two rings of nepheline syenite. The metasomatic fluid was aqueous and rich in calcium, carbon dioxide, iron, phosphorous, and niobium. The fluids were derived from the nepheline syenite magma.
6. The nepheline syenites crystallized from a magma of either a granite or basaltic parentage. The other rocks formed by hydrothermal solutions derived from this magma or as a result of metasomatism by these solutions of rocks in place. Fractionation of the parent magma was controlled by carbon dioxide at the top of the magma chamber. Crystallization took place over a long period of time in a stable area.

Parsons (1961) also interpreted the rocks of the ijolite-malignite band to be products of metasomatism.

The world–wide occurrence of ijolite within carbonatite complexes, its relatively consistent composition, and generally clearly igneous texture indicate to the author that the ijolite is likely the product of a magmatic liquid.

Preliminary experiments conducted by Philpotts (1967) would suggest that the magnetite–apatite veins found at Lackner Lake are a product of liquid immiscibility due to splitting of an alkali magma into three phases. Philpotts (1967) proposed that these three immiscible phases consist of (1) diorite, (2) iron–titanium oxide and (3) apatite, which co–exist between 850 and 1000°C. He suggested that high sodium contents, which characterize alkalic rocks, may play an important role in forming these immiscible liquids.

Analyses of samples of the various rock groups (Table A–2 in Appendix A) were plotted on AFM diagrams for comparative purposes only. Samples from the ijolite and ijolitized breccia (Unit 3a), plot in a tight cluster and appear to generally have a consistent composition (Figure 4a). The compositions of ijolites of this group are likely representative of the compositions of the original alkalic silicate melt.

AFM plots for the foliated units (Unit 4) display considerable scatter which undoubtedly reflects greater heterogeneity in rock composition (Figures 4b,c,d). This rock group displays greater textural and mineralogical variation than the ijolite and ijolitized breccia and may, in part, be a hybrid rock.

The nepheline syenites (Unit 5) (Figures 4e,f) also display considerable scatter on an AFM plot and the leucocratic to melanocratic nepheline syenites (Units 5a, 5b), in particular, could be contaminated phases. On both field and petrographic criteria the coarse, inequigranular, leucocratic nepheline syenite (unit 5c) would most likely represent an alkalic silicate melt.

The hybrid appearance of many exposures of this complex in combination with the fact that intruding phases of the complex are likely to have been crystal mushes, other phases the product of liquid immiscibility, and other phases the product of cumulate processes makes use of the chemical data to project evolving melt compositions difficult if not impossible.

An AFM plot prepared for carbonatite samples (Figure 4g) displays reasonably tight clustering. The carbonatite magma likely formed by a process of liquid immiscibility in a carbonated alkalic silicate magma. The immiscible cogenetic alkalic silicate melt is presently represented by the ijolitic rocks, with which the carbonatite is closely associated at Lackner Lake as well as at many other carbonatite complexes in Ontario and throughout the world.

Several investigators have proposed liquid immiscibility as a mechanism to generate carbonatite magmas from a carbonated alkalic magma (Hamilton *et al.* 1979; LeBas and Handley 1979; Nash 1972; Freestone and Hamilton 1980). Fluid inclusion studies on apatite from carbonatite and associated ijolite have established the cogenetic immiscible relationship between carbonatite and ijolite (Rankin and LeBas 1974; LeBas *et al.* 1977; LeBas and Aspden 1981). The observed close field relationship between these two rock types can be explained by a process of liquid immiscibility as suggested by LeBas and Handley (1979), Freestone and Hamilton (1980), and Nash (1972).

On the basis of petrography and field evidence the ijolitic rocks found at Lackner Lake have been cut by the nepheline syenite. The schistosities within the foliated ijolites, malignites and nepheline syenites were likely developed in these rocks at the time of syenite intrusion. The poikiloblastic–granoblastic textures observed in the foliated contact rocks of malignitic composition were also likely

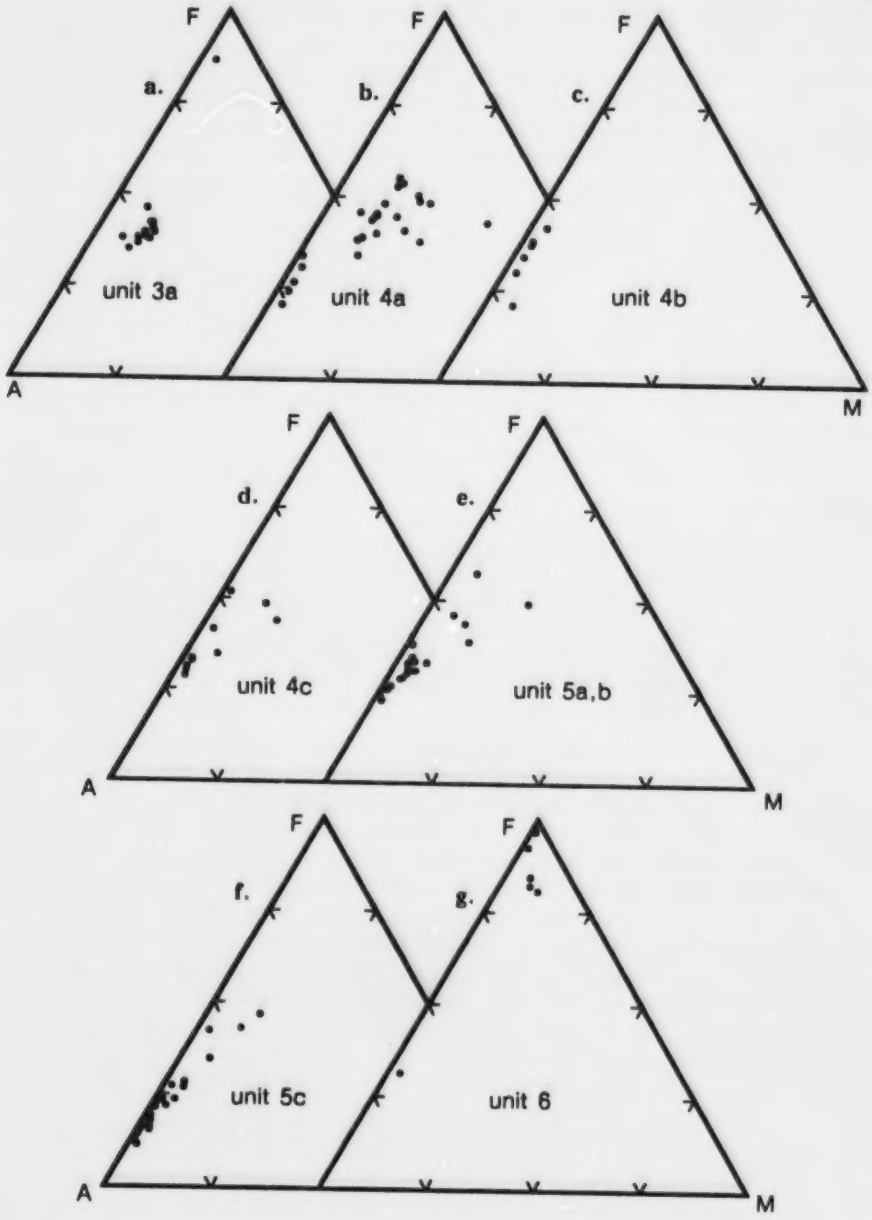

Figure 4. *AFM plots of samples from the Lackner Lake Alkalic Rock Complex.* **a.** *Ijolite and ijolite breccia, unit 3a.* **b.** *Melanocratic, foliated ijolite to malignite, unit 4a.* **c.** *Mesocratic, foliated malignite to nepheline syenite, unit 4b.* **d.** *Leucocratic, foliated nepheline syenite, unit 4c.* **e.** *Mesocratic to melanocratic, unfoliated nepheline syenite, malignite and ijolite, units 5a,b.* **f.** *Coarse-grained, mesocratic to leucocratic nepheline syenite to malignite, unit 5c.* **g.** *Carbonatite, unit 6.* $A = Na_2O + K_2O$; $F = FeO$ *(total)*; $M = MgO$.

developed at this time. The ijolitic rocks were likely metasomatically altered by fluid originating from the intruding nepheline syenite magma or from fluids derived from its cogenetic carbonatite magma. Evidence for this metasomatism can be interpreted from the poikiloblastic overgrowths on potassium feldspars and nepheline crystals and the fracture control for some of the pyrochlore mineralization that was described by Hodder (1961).

As previously discussed the carbonatite magma most likely originated as an immiscible phase of a carbonated alkalic mafic magma. The ijolitic magma is a magma that is cogenetic with the carbonatite magma. As to the origin of the carbonated alkalic mafic magma and nepheline syenite magma the strontium isotope data of Bell and Blenkinsop (1980) indicate that these magmas originated in the mantle. The strontium isotopic data indicate little interaction of the nepheline syenite and ijolite magmas with crustal rocks.

In summation, the above discussion considers only three magmas in the origin of the Lackner Lake complex and these are nepheline syenite, ijolite, and carbonatite. The ijolite and carbonatite magmas are cogenetic immiscible liquids, however the nepheline syenite may not be directly related petrogenetically to the other two magmas.

Mapping of numerous carbonatites by the author indicates a relative absence of nepheline syenites in association with the ijolite and carbonatite rocks that compose most, if not all, of the other mapped carbonatite complexes. The limited amount of syenite observed by the author to be associated with carbonatite complexes appears to be fenite resulting from metasomatism accompanying carbonatite emplacement. Therefore these syenites are not petrogenetically linked to a common parent magma composition.

In the first model being presented the carbonated alkalic mafic magma was emplaced first into an arcuate ring fracture from a mantle source area. The large volume of volatiles, alkali elements, and incompatible elements comprising this magma are likely the result of upper mantle metasomatism (Lloyd and Bailey 1975; Boettchner and O'Neil 1980; Van Kooten 1980). The focusing of these metasomatic fluids and emplacement of the resulting carbonated mafic alkalic magma was likely due to stress relief along a deep fracture associated with the Kapuskasing Structural Zone into which this complex intruded. Following this intrusive event a nepheline syenite magma, also of mantle origin, was emplaced along the same channel engulfing, intruding, and reacting with the previously emplaced ijolite. This intrusive sequence explains the cross–cutting relations and is consistent with the order of emplacement observed by the author in other alkalic rock intrusive complexes throughout northern Ontario. It has been observed that the mafic silicate phases have been consistently early in the order of emplacement, with lower–temperature more–evolved phases intruded last and cutting the earlier more mafic phases.

During emplacement, interaction between the nepheline syenite magma and ijolite rocks imparted the foliation features observed in the rocks lying between the nepheline syenite magma and ijolite. The granoblastic textures developed at this time as a contact metamorphic feature. The observed poikiloblastic (?) nepheline and potassium feldspars are a contact metamorphic feature. The malignite rocks displaying the granoblastic and porphyroblastic textures would be the result of metasomatic fluids from the nepheline syenite magma acting on the ijolite. This model is identical to that suggested by Hodder (1961) and Parsons (1961) except that ijolite is suggested to be the precursor to the malignites rather than wall rock gneisses. The gneisses must be rejected as a precursor of the malig-

nitic rocks on the basis of the strontium isotope data indicating an absence of crustal material.

The model requires the development of two magmas in the mantle. This requires continued mantle metasomatism coupled with two temperature perturbations since the nepheline syenite represents a lower temperature magma than the ijolite. A second metasomatic–thermal event is required to produce the nepheline syenite magma since all fusible components would have been removed in the earlier higher temperature event. This model is modified after Hodder (1961) and Parsons (1961) to be consistent with strontium isotope data and is supported by field observations. The author observed the same features and initially agreed with the basic ideas of Hodder (1961) and Parsons (1961). Having subsequently examined many alkalic rock–carbonatite complexes since mapping the Lackner Lake complex, combined with an expanding voluminous literature on the topic, the author recognizes that problems exist with the model above. Some field observations and thin section observations are unique to Lackner Lake and imply that the complex may have had a different emplacement history than the vast majority of the alkalic rock – carbonatite complexes examined in this study. Problems with the previous model are itemized below:

1. Nepheline syenite magmas exist at temperatures of approximately 770 to 900°C (Zyryanov 1981; Yudintsev *et al.* 1984; Gittins 1979). On the basis of fluid inclusion studies on apatite from ijolite the ijolite magma represents a temperature range of 950 to 1100°C (Rankin and LeBas 1974b). The comagmatic immiscible carbonatite magma can exist down to temperatures of 500°C (LeBas 1975b; Wyllie and Tuttle 1960). The aqueous carbonatite magmas are low density, fluid, and superheated with respect to the cogenetic ijolite magma (LeBas 1981).

   The temperature considerations of the magmas taking part in the formation of the Lackner Lake complex in the first model are as follows:

   A. It is unlikely if not impossible for a lower temperature magma such as the nepheline syenite magma to assimilate and react with the ijolite which would represent the crystallized product of a higher temperature magma. This difficulty leaves unexplained the observational evidence of extensive interaction between the two magma types.

   B. If nepheline syenite magma came after the ijolite magma, then two–stage mantle metasomatism and two–stage thermal perturbation would have had to take place. While not impossible it does make modeling more complex.

2. Nepheline syenites observed within other alkalic rock complexes do not display pervasive reaction and assimilation with their host rocks as do the Lackner Lake nepheline syenites. Reaction relationships in other complexes are limited in extent, implying that the nepheline syenite magmas are not capable of generating large volumes of metasomatizing fluids or excess thermal energy.

3. Granoblastic textures and porphyroblastic nepheline and potassium feldspars are restricted to the Lackner Lake complex and have not been observed at other alkalic rock complexes. The author has not observed the development of granoblastic textures and the extensive development of possible porphyroblasts in any complex where a later lower temperature nepheline syenite magma intrudes a rock crystallized from a higher temperature magma.

4. The pervasive development of heterogeneous rock compositions and textures combined with the various rock foliations, xenoliths, and schlieren

found in the syenitic rocks bordering the mafic silicate rocks (ijolites) are a feature that is atypical of other alkalic rock complexes examined in Ontario by the author. While xenoliths, schlieren, etc. do occur in many other complexes the convoluted banded, xenolith–rich, heterogeneous textured nature of the Lackner Lake nepheline syenites is not comparable in the relative degree of development.

Petrogenetic Model 2

As a consequence of the problems with the original interpretation presented by Hodder (1961) and Parsons (1961), a second model is proposed for consideration. This model is based on the emplacement of the nepheline syenite magma first and the ijolite magma second. This model eliminates the problems envisaged with the first interpretation.

1. The emplacement of the nepheline syenite magma first followed by a higher temperature ijolitic magma provides a temperature differential which would encourage hybridization between the two rock types.
2. The emplacement of the nepheline syenite magma first requires only one mantle thermal and metasomatic event. The first melt phase formed in a mantle metasomatic event would be the lowest temperature phase magma which in this case is nepheline syenite. This first formed magma should be emplaced first. The higher temperature carbonated alkalic mafic magma would form later in response to continuing mantle metasomatism and higher temperatures. This later magma would be emplaced into a ring fracture formed in the now more or less solid nepheline syenite.
3. The ijolite magma is rich in volatiles and alkali elements and is an excellent source for a metasomatizing fluid as exemplified in the fenitic halos that envelop carbonatite, but not nearly to the same extent as syenite complexes. This volatile and alkali rich fluid would provide an ample supply of metasomatizing fluid to explain the metasomatic features observed at Lackner Lake. The malignites are therefore the product of metasomatism from the ijolite magma and not the nepheline syenite magma as suggested by Hodder (1961).
4. The abundant volatiles and alkalies from the carbonated alkalic magma would encourage hybridization and melting of the lower temperature nepheline syenites. The intruding carbonated alkalic mafic magma would then be enveloped in a sheath of rheomorphic breccia composed of xenoliths of ijolite and nepheline syenite, partially digested and plasticized xenoliths, and xenocrysts set in an anatectic melt. Crystallization and fracturing of the higher temperature ijolite magma would permit anatectic nepheline syenite melt from the surrounding sheaf of rheomorphic breccia to intrude the younger ijolitic rocks confusing true age relations. The various foliations, i.e. banding, schistosity, etc., are a product of intrusion, alteration, and tectonism in the rheomorphic zone lying between the nepheline syenite and intruding carbonated alkalic mafic magma.

   The author has observed the development of rheomorphic breccias on both the east and west flanks of the Port Coldwell alkalic rock complex where gabbro intruded intermediate to felsic metavolcanics or metasediments of Archean age. The morphology of the xenolithic fragments and foliations observed at Port Coldwell are reminiscent of the features seen in some nepheline syenite outcrops at Lackner Lake. Anatectic intrusions from Archean rheomorphic breccia zones cut the Port Coldwell gabbros and could

lead one to consider the Port Coldwell alkalic rock complex as Archean in age rather than Proterozoic, its true age.

5. The later emplacement of carbonated alkalic mafic magma provide the heat, tectonism, and metasomatic additions required to develop the granoblastic and poikiloblastic nepheline and potassium feldspars. These textures are metasomatic, contact metamorphic in origin.

6. Immiscible splitting of the carbonated mafic alkalic magma would produce an ijolite magma and a cogenetic superheated carbonatitic magma. This carbonatite magma is an additional source for voluminous quantities of metasomatic fluids as is exemplified in fenitic halos enveloping carbonatite complexes. These fluids would react and intrude the consolidated nepheline syenite and ijolite rocks as the highly fluid, low viscosity, carbonatite magma cooled and crystallized. This carbonatite magma is now represented by dike-like carbonatite bodies within the ijolitic rocks at Lackner Lake.

Magnetite-Apatite

Hodder (1961) suggested that a relationship exists between the nepheline syenite and magnetite-apatite dikes. The author has not observed such dikes or veins in other nepheline syenites. Consequently, if the relationship is real, the genesis must result from a unique set of conditions at Lackner Lake. Of the three magma types, nepheline syenite, ijolite and carbonatite, the carbonatite magma contains by far the highest concentrations of titaniferous magnetite and apatite. Indeed it is common for carbonatites to contain concentrations of magnetite-apatite. It would appear most likely that the magnetite-apatite veins at Lackner Lake may be carbonatite-related. The veins may therefore be the result of deposition from metasomatizing fluids in fractures within the nepheline syenite and to a lesser extent the ijolite. The alterations marginal to the veins are consistent with a fenitic alteration that characterizes carbonatites.

Badham and Morton (1976) and Badham (1978) proposed liquid immiscibility as the mechanism by which magnetite-apatite bodies were generated in association with intermediate intrusive rocks in the area of Great Slave Lake, Northwest Territories. Keller (1982) has also proposed liquid immiscibility for the generation of magnetite-apatite rocks in the Morin complex of Quebec. The Lackner Lake magnetite-apatite deposits occupy fractures and their emplacement as an oxide-apatite magma or as a deposition from a fluid appears more likely than a crystal settling mechanism. The alteration of the nepheline syenites and ijolites marginal to these magnetite-apatite filled fractures is identical to that of fenitization which is commonly associated with carbonatite complexes.

Scott (1963) has proposed solid state injection into fractures from an unknown depth to explain the magnetite-apatite veins at Lackner Lake. He found that magnetite-fluorapatite magma has a binary eutectic at 1540°C and 56% magnetite. He considered this temperature to be too high for a magnetite-fluorapatite magma to exist. The author concurs with Scott (1963) that the magnetite-apatite veins were not emplaced at a temperature as high as 1540°C. The veins cut nepheline syenite and ijolitic rocks and display very sharp contacts. Nepheline syenite rocks melt around 900°C and ijolite rocks around 1100°C and the injection of such a hot magma would not be expected to preserve sharp contacts. The author has not observed deformation features in the dikes that could be interpreted as the result of solid state emplacement as suggested by Scott (1963).

GEOCHRONOLOGY

Gittins *et al.* (1967) obtained an isotopic age of 1090 Ma for the Lackner Lake complex, using potassium–argon techniques.

Owen and Faure (1977) reported a rubidium–strontium isochron age of 1078 ± 7 Ma for the complex. Figure 5 is the isochron plot for this age determination (Owen and Faure 1977). Table 3 is a description of the samples used in establishing the isochron (L.B. Owen, personal communication, 1977). Samples for the age determination were collected in 1970 by Owen while employed with the Ontario Department of Mines. Sample B is likely from the carbonatite dikes cutting ijolitic and malignitic rocks of mineralized zone 8. The locations of samples E and F are uncertain, but they are likely from zone 8 where 2–inch diameter coring of the niobium–bearing carbonatite dikes was completed.

Bell and Blenkinsop (1980) obtained a rubidium–strontium isochron age of 1138 ± 29 Ma for the Lackner Lake complex, and an age of 1092 ± 21 Ma when they included the data of Owen and Faure (1977). Samples for the Bell and Blenkinsop (1980) study were taken from drill core of Falconbridge Nickel Mines Limited, and this core was examined by the author (samples 938, 939, 952, Appendix A).

The strontium isotope ratios reported by Bell and Blenkinsop (1980) are 0.7027 ± 0.0002 and 0.7028 ± 0.0003. These ratios are consistent with a mantle source for the magmas, reflecting little crustal contamination. The strontium isotope ratios indicate that the derivation of the malignites by metasomatism of crustal gneisses as proposed by Hodder (1961) and Parsons (1961) is unlikely.

METAMORPHISM

The Lackner Lake Alkalic Rock Complex intrudes orthogneiss and paragneiss of the Kapuskasing Structural Zone of the Superior Province of the Canadian Shield. The gneissic rocks trend northeast, dip steeply and have been metamorphosed to the granulite facies rank of regional metamorphism (Thurston *et al.* 1977). Observations by Hodder (1961) and Parsons (1961) indicate that these gneisses have been fenitized by metasomatic fluids derived from the intruding alkalic magma.

Within the foliated ijolite, malignite, and syenite (Unit 4), granoblastic and granoblastic elongate textures were noted in a high proportion of the thin sections examined. Hodder (1961) recognized these textures and classified the rock as hornfels. The rocks of unit 4 have developed a contact metamorphic texture resulting from the emplacement of the nepheline syenite magma (petrogenetic model 1) or by the emplacement of the ijolite magma into previously emplaced nepheline syenite magma (petrogenetic model 2). This contact hornfels may be of hornblende hornfels rank but the customary indicator minerals are lacking. The author has not observed the development of metamorphic textures in other alkalic rock suites during the present project. Perhaps the ijolite and ijolitized breccia and the foliated ijolite, malignite and syenite (Units 3 and 4) represent either a ring dike intrusion that had cooled before being deformed and metamorphosed during emplacement of the younger nepheline syenite magma or a ring dike emplaced into a solidified nepheline syenite.

The inclusion rings of apatite and aegirine–augite are developed best in the foliated nepheline syenite and the mesocratic nepheline syenite (Units 4c, 5a). These units are in part gradational into each other; the foliated nepheline syenite

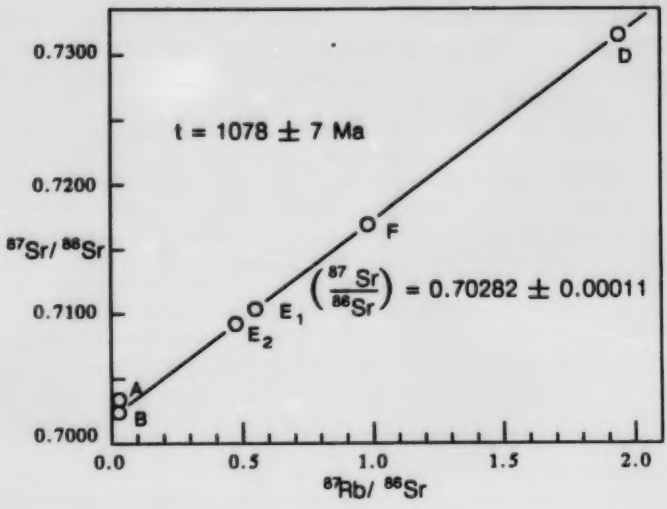

Figure 5. *Rb/Sr isochron plot of whole-rock samples and separated minerals from the Lackner Lake complex. Modified after Owen and Faure (1977).*

TABLE 3. DESCRIPTIONS OF SAMPLES USED FOR AGE DETERMINATION BY RUBIDIUM-STRONTIUM ISOCHRON (PERSONAL COMMUNICATION, L.B. OWEN AND G. FAURE, UNIVERSITY OF WISCONSIN, 1977). SEE FIGURE 5 FOR ISOCHRON PLOT.

Sample A — Apatite

Concentrates were prepared from massive magnetite–apatite mineralization. Samples were obtained in the form of 1-inch diameter core, and from outcrops exposed by quarrying at the No. 6 ore body. Green apatite grains, averaging about 0.5 mm in diameter, were identified as carbonate species by X-ray diffraction analysis ($Ca_{10}(PO_4)_6(CO_3)H_2O$). Microscopic examination indicated inclusions were abundant, but only zircon could be positively identified from its characteristic habit. Intergrowths of magnetite made purification of apatite concentrates difficult.

Sample B — Carbonatite

Massive, white 2-inch diameter core samples, containing more than 95% calcite, with grain sizes exceeding 2 cm, and minor magnetite, apatite, pyroxene, and black garnet (possibly melanite as suggested by Hodder 1961).

Sample C — Magnetite

Samples were as described previously for apatite. The magnetite was massive or intergrown with apatite, and concentrates contained trace amounts of pyrrhotite, pyrite, chalcopyrite, and possibly bornite.

Sample D — Ijolitic Nepheline Syenite

Samples were obtained from outcrops exposed at the open pit on the No. 6 zone. The rock is mesocratic and contains blebs of nepheline–alkali feldspar intergrowths, ranging in diameter from 4 to 20 mm, and comprising from 35 to 40 percent of the rock. The dark grey matrix is fine grained and ijolitic in composition. This sample may be called ijolitic or transitional nepheline syenite as it belongs to a sequence which varies in composition from magnetite veins to ijolite to ijolitic nepheline syenite to nepheline syenite (Hodder 1961).

Sample E_1 — Nepheline Syenite

The sample was obtained as 2-inch diameter core, and is similar to Parsons' (1961) type 5c nepheline syenite. It is a coarse-grained, inequigranular, almost leucocratic rock of juvitic composition. Laths of alkali feldspar, up to 1.5 cm in length, and euhedral, rectangular nepheline, up to 6 mm long, are set in a fine-grained matrix of intergrown nepheline and alkali feldspar. The rock contains about 10 percent aegirine–augite in the form of irregular patches up to 3 mm long. The nepheline has been altered along grain boundaries and fractures to cancrinite, and feldspar is altered to sericite at grain boundaries. Less than about 0.5 percent magnetite.

Sample E_2 — Alkali Feldspar Concentrate

Separated from E_1 by magnetic and heavy liquid techniques. Partial separation of feldspar and nepheline was verified by X-ray diffraction analysis.

Sample E_3 — Nepheline Concentrate

Sample F — Ijolite

The sample was obtained as 2-inch diameter core. It is an unaltered melanocratic, fine-grained rock consisting of about equal amounts of nepheline and aegirine–augite with minor amounts of feldspar laths up to 1.5 mm long (see Hodder 1961).

(Unit 4c) is the contact metamorphosed facies of the nepheline syenite (Unit 5a). The inclusion rings are interpreted to be the product of contact metamorphism–metasomatism. The outer shell on the perthite feldspars is the result of metamorphic overgrowth and recrystallization, and the grains could therefore be considered porphyroblastic. Of the numerous alkalic rock suites from Ontario examined by the author, only the Lackner Lake suite contains these inclusion rings. This implies that special conditions or a distinctly different process has been active at Lackner Lake. Granoblastic textures and inclusion rings are not present in samples collected away from the contact area between the above two lithologies (units 4 and 5).

The overgrowths on the perthitic feldspars and the presence of fracture–controlled pyrochlore mineralization (Hodder 1961) could suggest that the ijolitic rocks were metasomatized by fluids originating from the intruding nepheline syenite magma or carbonatite magma, associated with the ijolitic magma (petrogenetic model 1) but the extensive metasomatism observed may be better explained if the volatile–rich ijolite magma was emplaced last into the nepheline syenite (petrogenetic model 2). The possibility of two periods of fenitization occurring at Lackner Lake warrants further investigation if the nepheline syenite is the younger intrusive phase (petrogenetic model 2). The first period would have occurred at the time of ijolite–carbonatite intrusion and the second period at the time of nepheline syenite emplacement. Since fluids of similar composition are expected to be involved, it may prove difficult recognizing two periods of metasomatism (fenitization).

The minor amounts of patch perthite present are interpreted by the author as late–stage deuteric or autometamorphic in origin. This type of perthitic texture is common in some alkalic rock complexes but is not common at Lackner Lake. Its relatively uncommon occurrence at the Lackner Lake Complex is in part a function of the relatively low plagioclase content of this rock suite and perhaps in part due to the lack of subsolvus exsolution.

The presence of clinopyroxene altered to a pleochroic amphibole, and narrow biotite rims on the occasional magnetite grain, are also considered by the author to reflect late–stage deuteric or autometamorphic processes during the first stages of crystallization of the alkaline magma.

There is no evidence that the Lackner Lake Alkalic Rock Complex has been affected by a regional metamorphic event.

STRUCTURAL GEOLOGY

REGIONAL SETTING

The Lackner Lake Alkalic Rock Complex lies near the southern end of the Kapuskasing Structural Zone of the Superior Province of the Canadian Shield. The Kapuskasing subprovince is characterized geophysically by a northeast–trending zone of gravity highs and pronounced linear aeromagnetic trends (Innes 1960; ODM–GSC 1970). This anomalous gravity zone has been interpreted as an upwarp in the Conrad discontinuity caused by major regional faulting and the formation of a complex horst structure (Wilson and Brisbin 1965; Bennett *et al.* 1967). This prominent regional structure extends from the south end of Hudson Bay southwestward, becoming broader and more ill–defined as it approaches the Lake Superior basin.

LOCAL STRUCTURE

Foliations of several types occur within the rocks of the Lackner Lake Alkalic Rock Complex. These are: (1) schistosity; (2) gneissosity; and (3) trachytoidal textures. The trend of all types of foliation is tangential to the outline of the complex and dipping steeply inward.

The schistose rocks have a significant biotite content. The subparallel orientation of the biotite grains imparts a schistosity or cleavage to the rocks, which makes them easily split with a hammer. The development of schistosity and at least some of the gneissosity likely took place at the time of emplacement of the nepheline syenite. Metasomatism, recrystallization, and contact metamorphism also took place at this time. Schistose ijolitic rocks have not been observed by the author at other carbonatite–alkalic complexes within Ontario.

Gneissosity has two forms which in places may be gradational into each other. Several outcrops of ijolite have a subtle banding due to variations in the ratio of pyroxene to nepheline + feldspar. The origin of this variation is uncertain, but may be due to separation of crystals by flow during emplacement.

Along the contact between the foliated ijolitic rocks and the leucocratic nepheline syenite, schlieren or elongated xenoliths impart a banding to the nepheline syenite. This banding results from local partial assimilation of the foliated units and from flow segregation during emplacement of the mesocratic nepheline syenite.

Trachytoidal textures are best developed in the mesocratic to leucocratic nepheline syenite which contains tabular feldspars and has an inequigranular–porphyritic–seriate texture. The subparallel orientation of the feldspar laths resulted from laminar flow at the time of emplacement. Subtle trachytoidal textures were also recognized in the coarse-grained, inequigranular, leucocratic, nepheline syenite (Unit 5c); the trachytoidal texture is difficult to recognize in this syenite because the feldspars are stubby and uniform in size.

Parsons (1961) described the structure of the complex as follows:

"Plotting of magnetic data illustrates the circular pattern inherent to the area. This circular pattern is also confirmed by the distribution of the major rock types and by the foliation present in some of these types.

"Drilling by Multi-Minerals Limited in the general area of their orebodies indicated dips as flat as 45 degrees inward for the foliated rocks, carbonatite dikes, and the outer ring of coarse leucocratic nepheline syenite. The dips of foliation in the outcrops are generally steeper, and in some cases are nearly vertical.

"Magnetic data indicate that the main mass of foliated rock, as exposed on the west flank, breaks and fingers into several zones as it swings around into the other flanks; these zones are separated by syenite. This suggests that there may be more than one ring, or partial ring, of injected nepheline syenite.

"Late faulting is indicated by topographical depressions, and confirmed in some cases by interruptions in the magnetic pattern. Some of these probable faults are shown on [Map 2008]."

Hodder (1961) reported that the complex is cut by northeast–trending regional faults and by five north– to northwest–trending faults in the northern part of the complex. The nature of the faults and their displacement are unknown (Hodder 1961). Hodder interpreted the presence of the faults on the basis of rock type distribution and topographic features but did not show them on the map accompanying his report.

The author has made no attempt to verify the structural interpretation of Hodder (1961) and Parsons (1961).

MAGNETIC AND RADIOACTIVE DATA

Parsons (1961) made a compilation of the magnetic and radioactive data that was available at the time of his study. This work was undertaken shortly after the most intensive exploration activity had been completed on the complex, and the present author has not attempted to completely re-assemble these data. Parsons (1961) summarized the magnetic and radioactive data as follows:

"The whole alkaline complex has been covered by the ground magnetic surveys of various companies. The results of these surveys have been compiled. Although this type of compilation is rather unsatisfactory owing to difference in instruments, operators, base magnetic values, etc., nevertheless the close association of niobium mineralization with magnetite-bearing formations strongly justifies presentation of this data.

"The surveys, on ground held by M. Silverman and on that originally held by Dominion Gulf Company, are indicated to have a comparable base gamma value, so this base gamma was accepted for the compilation. The magnetic readings over ground held, or formerly held, by Multi-Minerals Limited and on the Le Brasseur, Derraugh, and MacDonnell property were reduced by 7,500 gammas, and the surveys by Claymac Mines Limited were reduced by 4,000 gammas, so that they would be roughly comparable in magnetic intensity to the surveys mentioned above. For the isolated Hebden [Portage] Lake complex, the gamma values are presented as so much above the base level for the immediate area.

"The stronger anomalies, i.e., those over 5,000 gammas, are due to magnetite veins or blebs in ijolite breccia, to massive magnetite-apatite bodies, or to a replacement of foliated rocks by these minerals. The foliated ijolites and malignitic rocks give distinct linear anomalies, generally under 5,000 gammas. The intrusive syenites, even when melanocratic, are relatively non-magnetic.

"Radioactivity is widespread throughout the complex and is particularly noticeable in the foliated rocks and ijolites. It is generally most pronounced in the rocks that contain such minerals as apatite, dark-green garnets, and magnetite. It is due both to pyrochlore and rare-earth minerals such as monazite. As in the Nemegosenda area, rare-earth minerals usually cause the highest radioactive anomalies."

RECOMMENDATION FOR FUTURE STUDY

The present study was undertaken to gather samples for a chemical and petrographic comparison of the Lackner Lake Alkalic Rock Complex with other, similar complexes within Ontario. Much additional work is needed to unravel the petrologic significance of the metamorphic textures found in the foliated units and the local effect of assimilation by the intruding nepheline syenite magma. Additional study is needed to determine whether assimilation has had any effect on differentiation trends of the intruding magma and ultimately on rock classifications.

A re-examination of the ijolitic and foliated units (units 3 and 4) is necessary in light of more recent ideas concerning alkalic rock – carbonatite complexes to more precisely determine whether these units are metasomatized gneisses or magmatic in origin. The author considers the ijolite and nepheline syenite to be of magmatic origin as they are mineralogically and texturally identical to similar rocks occurring in many Ontario alkalic rock – carbonatite complexes.

If the complex is the subject of an extensive drill program at a future date, a detailed chemical, trace element, petrographic, petrologic, and microprobe study of the specimens obtained is warranted. Additional study is warranted to positively establish the order of emplacement of the nepheline syenite and ijolite magmas.

Mineralization and vein structures were best exposed at the time Parsons (1961) and Hodder (1961) examined the complex, and their descriptions of the mineral deposits are presented here.

Hodder (1961) reported that at Lackner Lake pyrochlore occurs in three ways:

"1. As separate fine grains or clusters in the alkaline silicate rocks, principally in the ijolites and malignites, but also in very minor amounts in the equigranular nepheline syenites and nepheline syenite of the outer ring. Pyrochlore grains are mostly associated with grain boundaries of aegirine-augite but they may also be enclosed within any of the rock-forming minerals.

"2. In fine, disseminated grains in the magnetite-apatite bodies such as No. 6 orebody and also in carbonate rock.

"3. As euhedral grains in nepheline stringers that traverse malignites and ijolites and the pink nepheline fillings in the brecciated ijolite at the southeast end of Beaver Pond."

Hodder (1961) described pyrochlore compositions as being highly variable. This variability was described as follows:

"Two chemical analyses of pyrochlore from the Multi-Minerals property are given ... [Table 4]. From these analyses it is evident that the composition of the pyrochlore varies considerably. The relationship between chemical composition and colour is not clear. In Interim Report

TABLE 4. ANALYSES OF PYROCHLORE FROM MULTI-MINERALS LIMITED'S PROPERTY (FROM HODDER 1961; NICKEL 1955a,b).

	A	B
Nb_2O_5	46.0	58.1
Ta_2O_5	1.4	2.8
U_3O_8	12.6	1.2
ThO_2	4.7	–
CaO	27.0	16.9
MnO	0.2	0.3
Fe_2O_3	3.0	11.0
ZrO_2	0.5	–
TiO_2	2.5	9.1
MgO	0.4	0.28
Ce_2O_3	1.3	–
La_2O_3	0.3	0.32
Sy_2O_3	0.1	–

Method.
Recalculated, semiquantitative spectrographic analyses of pyrochlore concentrates.

Samples.
A – ijolite.
Calculated formula:
$(Ca_{1208}Mg_{88}Mn_{70}Ce_{36}La_{40}DyTh_{42}Zr_{1018}U_{106})(Nb_{888}Ta_{18}Ti_{78}Fe_{80}{}^{+++})$
$(O_{8324}A_{4\cdot6}B_1)_{11\cdot6}$
From Nickel 1955a.

B – foliated malignite.
Calculated formula:
$(Ca_{301}Mg_7Mn_{42}La_2U_3)$ $(Nb_{438}Ta_{12}Ti_{112}Fe_{120}{}^{+++})(O_{1816}A_1B_2)_{5\cdot4}$
From Nickel 1955b.

710-ML of the Mines Branch, Nickel (1955) described alpha track exposures where the darker pyrochlore produced more tracks than the lighter pyrochlore, but in Interim Report 716-ML he stated that the different coloured grains did not produce distinguishable alpha tracks. Nickel also noted that the pyrochlore is metamict and produces an X-ray diffraction pattern only after ignition."

One of Hodder's samples ("A") was from Multi-Minerals Limited zone 6 and the other ("B") from zone 8. The pyrochlore has a grain size of 0.005 mm to 0.5 mm. In the case of zone 8 the pyrochlore is closely associated with nepheline and feldspar as irregular aggregates (Nickel 1956). Tests indicated a significant uranium and thorium content in the pyrochlore from zone 6.

Magnetite and magnetite-apatite veins are common on the Multi-Minerals property and Hodder (1961) described these veins as follows:

"The magnetite-apatite deposits that have been most fully explored in the Multi-Minerals claims are elliptical in plan, up to 200 feet wide and 500 feet long, and they have been probed to a depth of at least 500 feet by diamond drilling. These deposits are composed principally of coarse-grained magnetite and apatite with minor amounts of pyroxene and pyrochlore. Foliation is caused by orientation of apatite crystals and segregation of apatite and magnetite into layers up to 3 inches wide. The apatite is emerald green and contrasts with the shiny black magnetite in hand specimen. Ilmenite lamellae occur within the magnetite grains. Large fragments of ijolite and small fragments of nepheline syenite are included within the magnetite-apatite rock, but it is difficult to decide if these patches of silicate rock are true inclusions or independent intrusions. The contact between the apatite-magnetite rock and the ijolite is sharp where encountered in drill-core, but is not well exposed at the surface. The contact between the nepheline syenite patches and the magnetite-apatite rock is exposed in several places in the open pit at the No. 6 orebody. There, it is sharp with no reduction in grain size of either rock type at the contact. Considerable magnetite in the syenite occurs at the contact, and feldspar is present in the magnetite-apatite rock. Diamond-drill hole R-65 penetrated a short section of brecciated rock cemented solely by apatite.

"In addition to the bodies of magnetite-apatite, veins of solid magnetite are exposed in the McVittie pit and in most of the outcrops eastward to Beaver Pond. There is one major vein 3 feet wide that strikes north, is almost vertical, and is attended by many smaller stringers, averaging 2 inches across, scattered through the wall rock. In the outcrops around Beaver Pond there is also one major vein that averages 3 feet in width and that strikes northwest with a dip of 50° NE. At Beaver Pond the magnetite veins cut the nepheline syenite of the outer ring, and pyroxene is developed in the wall rock. Analyses of the magnetite from the two types of occurrence are [given in Table 5].

"Analyses are taken from the annual report of Multi-Minerals Limited. Titanium in the analyses confirms the petrographic evidence that the intergrowths in the magnetite are ilmenite. The phosphorus, silica, manganese and sulphide indicate that the magnetic fraction used for analysis was not solely magnetite. From magnetic separations of the magnetite-apatite rock and sieving at minus 48 mesh, minus 65 mesh, and minus 100 mesh the average was 64 percent total iron, 6 percent titanium, 0.27 percent phosphorus and less than 1 percent silica. The apatite concentrates average 16.6 percent phosphorus or 83 percent bone phosphate-lime, with approximately 1.0 percent iron and 0.05 percent titanium. A commercial analysis of the apatite is given below in weight percent. BPL means bone phosphate of lime, $Ca_3P_2O_8$.

P_2O_5	*BPL*	*Acid.sol. iron*	*Total Fe*	*CaO*	*F*	SiO_2	Al_2O_3
35.1	76	1.6	1.9	49.1	2.7	4.3	1.1

Graham (1955) of the Dominion Gulf Company described cerianite from the east side of the Lackner Lake Alkalic Rock Complex. The mineral occurs as radioactive, translucent, greenish amber octahedra in carbonate rock. The mineral is isostructural with thorianite and uraninite and is associated with sphene, zircon, perovskite, calcite, cancrinite, pyrrhotite, pyrite, chalcopyrite, and sphalerite. An analysis of cerianite is given in Table 6.

In addition to niobium and iron potential the complex also has potential as a source of phosphorus from apatite. The apatite would likely be a by-product of

TABLE 5. CHEMICAL COMPOSITION OF MAGNETITE FRACTION FROM NO.6 MAGNETITE-APATITE ZONE AT LACKNER LAKE COMPLEX (HODDER 1961).

1. Average of 14 analyses of the magnetite fraction from the No.6 magnetite–apatite zone at Beaver Pond.

	Weight%
Total Iron	48.95
Phosphorus	2.65
Titanium oxide	6.40
Silica	1.69
Manganese	0.79
Sulphur	0.43

2. Average of 12 analyses of magnetite from the largest vein at Beaver Pond.

	Weight%
Total Iron	62.20
Phosphorus	0.04
Titanium oxide	9.18
Silica	0.76
Manganese	1.34
Sulphur	0.03
Lime	0.03
Alumina	1.31
Magnesia	0.19

TABLE 6. CERIANITE COMPOSITION (FROM GRAHAM 1955).

Oxide	Weight %
CeO_2	80 ± 20
ThO_2	5.1 ± 0.5
Nb_2O_5	1.8 ± 0.2
La_2O_3	1.5 ± 0.2
Y_2O_3	1.2 ± 0.2
Yb_2O_3	1.1 ± 0.1
Ta_2O_5	0.6 ± 0.05
ZrO_2	0.6 ± 0.05
U_3O_8	None Detected

niobium and/or magnetite extraction. The apatite contains rare earth elements and a study of these elements was conducted by X–ray Assay Laboratories Limited for Multi–Minerals Limited. Table 7 shows the content of rare earth elements extracted from an apatite concentrate.

To date exploratory work on the Lackner Lake Complex has disclosed niobium, iron, uranium, phosphorus, and rare earth element mineralization of potential economic interest.

Tables 8, 9, and 10 summarize exploration work on the complex.

Magnetite and apatite samples obtained from the drill core of Falconbridge Nickel Mines Limited were analysed spectrographically (analyses by Geoscience Laboratories, Ontario Geological Survey) for Ba, Bi, Co, Cr, Cu, Li, Mn, Mo, Nb, Ni, Pb, Sr, V, Y, Zn, Zr, La, Nd (Table 11). The high niobium, strontium, and rare earth element concentrations are typical of alkalic rock – carbonatite complexes.

TABLE 7. RARE EARTH ELEMENT EXTRACT FROM MULTI-MINERALS LIMITED APATITE CONCENTRATE INDICATES 2.75% REE CONTENT OR 55 POUNDS PER TON OF CONCENTRATE (DATA FROM MULTI-MINERALS REPORTS ON FILE WITH ASSESSMENT FILES RESEARCH OFFICE, ONTARIO GEOLOGICAL SURVEY).

		Weight %	Equivalent lbs./ton
La_2O_3	Lanthanum	11	6.05
CeO_2	Cerium	38	21.00
Pr_2O_3	Praeseodymium	5	2.75
Nd_2O_3	Neodymium	13	7.05
Sm_2O_3	Samarium	5	2.75
Y_2O_3	Yttrium	5	2.75
ThO_2	Thorium	8	4.4
Subtotal		85	46.75
Eu_2O_3	Europium	0.1-0.5	
Gd_2O_3	Gadolinium	2-4	
Tb_2O_3	Terbium	0.1-0.5	
Dy_2O_3	Dysprosium	2-4	
Ho_2O_3	Holmium	0.1-0.5	
Er_2O_3	Erbium	0.5-1	
Tm_2O_3	Thulium	0.1-0.5	
Yb_2O_3	Ytterbium	0.5-1	
Lu_2O_3	Letetium	0.1-0.5	
Subtotal		15	8.25
TOTAL		100	55

TABLE 8. EXPLORATION PROGRAMS AT LACKNER LAKE.

Company	Approximate date of work
Apamag Mines Ltd.	1955
Chyka Mines Ltd.	1954
Claymac Mines Ltd.	1955
Dominion Gulf Co.	1954
Falconbridge Nickel Mines Ltd.	1959
MacDonnell-LeBrasseur-Derraugh	1952
Multi-Minerals Ltd.*	1954 to present
Ontario Rare Metal Mines Ltd.	1954
Silverman	1954, 1959
Union Carbide Canada Mining Ltd.	1969

*Property held in the name of Nemegos Uranium Corp.

TABLE 9. SUMMARY OF DIAMOND DRILLING WITHIN AND MARGINAL TO THE LACKNER LAKE ALKALIC ROCK COMPLEX.

Company	No. of Holes	Footage
Apamag Mines Ltd.	5	2,130
Chyka Mines Ltd.	28	10,514
Claymac Mines Ltd.	9	2,722
Dominion Gulf Co.	3	2,008
Falconbridge Nickel Mines Ltd.	14	3,336
MacDonnell-LeBrasseur-Derraugh	4	1,003
Multi-Minerals Ltd.		
A-Series	10	6,499
B-Series	10	6,269
C-Series	2	372
D-Series	1	1,610
E-Series	1	1,170
P-Series	31	4,393
R-Series	130	68,106
NX-Series	4	977
(no letter)	10	9,758
1978 Series	6	2,178
Ontario Rare Metal Mines Ltd.	5	2,281
Silverman		
1954	14	4,117
1959	20	2,981
Union Carbide Canada Mining Ltd.	1	801
Total	308	133,338 (40 101 m)

TABLE 10. ESTIMATED RESERVES OF MINERALIZED ZONES OF THE LACKNER LAKE ALKALIC ROCK COMPLEX, BASED ON DIAMOND DRILLING.

Falconbridge Nickel Mines Ltd.*

Zone 1. 2,000,000 tons grading 18.9% soluble Fe, 3.70% P and 7.87% soluble Al_2O_3 to a depth of 450 feet.

Zone 2. 500,000 tons grading 22.3% soluble Fe, 2.89% P and 5.91% soluble Al_2O_3 to a depth of 450 feet.

Multi-Minerals Ltd.**

Zone 3-4. 37,000,000 tons grading 21.3% apatite, 0.17% Nb_2O_5 to 500 feet depth.

Zone 6. 5,024,250 tons grading 69.6% magnetite, 21.9% apatite to a 500 foot depth. Zone contains 2.72% rare earth oxides in the non-metallic fraction, which is over 90 volume percent apatite.

Zone 8. 80,000,000 tons averaging 0.25 Nb_2O_5 to a depth of 800 feet.

*Files of Falconbridge Nickel Mines Ltd.; mineralized zones located in southeast corner of the complex, see Parsons (1961), Naldrett (1959).

**Canadian Mines Handbook 1969-1970, p.241.

TABLE 11. SPECTROGRAPHIC ANALYSES (PPM) OF MAGNETITE-APATITE SAMPLES FROM DRILL CORE OF FALCONBRIDGE NICKEL MINES LTD.*

Sample	Ba	Bi	Co	Cr	Cu	Li
L1-94.6	50	2.4	49	13	194	<3
97.7	70	4.0	47	10	166	3
101.2	50	25.8	24	<5	44	10
107.3-6	90	2.8	61	14	205	8
112.6	40	14.3	32	9	58	8
116.2	50	2.5	68	9	211	3
123.9	40	28.8	36	12	44	6
126.4	40	20.6	35	11	42	<3
130.3	50	28.7	43	13	72	<3
134.3	50	29.5	39	12	63	3
L2-153.0-2	60	2.3	21	6	44	12
170.5-7	80	2.4	16	6	33	12
176.3	50	5.4	46	6	114	<3
181.4	40	56.6	44	6	109	4
186.35	40	19.5	61	5	198	<3
191.3	50	9.0	54	6	145	4
195.4	30	13.7	64	6	186	<3
201.6	70	11.6	32	6	78	<3
L6-103.7	40	2.9	31	<5	47	<3
120.65	30	24.5	38	6	72	<3
127.3	40	6.6	55	<5	185	<3
133.5	50	9.9	8	<5	10	<3
137.3	30	34.9	25	7	40	<3
142.7	40	51.5	29	<5	66	<3
146.3	320	15.0	77	9	260	<3
150.6	30	25.6	51	10	175	<3
156.2	70	29.6	27	6	38	<3
157.0	30	11.4	54	7	182	<3
163.8	260	20.7	56	9	152	<3
L9-131.6	40	4.2	35	12	54	<3
142.8	110	19.3	34	6	81	<3
153.6	190	2.1	25	9	48	28
159.7	40	3.1	37	10	76	4
168.8	80	5.4	24	10	44	<3

*Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
Sample numbers indicate drill hole number + depth in feet of intersection. Drill holes are shown on Figure 3 (Chart A) with 'FN' prefixes.

TABLE 11. CONTINUED.

Sample	Mn%	Mo	Nb	Ni	Pb	Sr
L1-94.6	0.88	<5	<5	75	13	1610
97.7	1.30	7	190	57	<10	30
101.2	0.41	10	20	13	38	3370
107.3-6	0.71	<5	40	86	10	790
112.6	0.49	8	10	22	28	2370
116.2	0.96	<5	<5	75	<10	760
123.9	0.81	7	<5	17	44	2410
126.4	0.82	6	6	17	59	2470
130.3	0.77	<5	<5	27	54	2220
134.3	0.72	7	<5	25	54	2720
L2-153.0-2	0.26	7	<5	14	66	5015
170.5-7	0.28	14	10	9	90	6855
176.3	0.51	8	<5	50	45	3770
181.4	0.57	8	<5	41	54	3290
186.35	0.67	6	10	73	37	2310
191.3	0.68	<5	510	57	33	3780
195.4	0.61	<5	560	63	32	3410
201.6	0.46	<5	600	20	75	6240
L6-103.7	0.68	<5	290	16	25	5380
120.65	0.64	<5	440	25	48	3810
127.3	0.41	<5	420	63	86	6420
133.5	0.24	<5	270	<5	169	9360
137.3	0.58	<5	370	10	43	5620
142.7	0.44	<5	340	18	26	6710
146.3	0.69	<5	600	92	<10	1170
150.6	0.63	<5	440	58	<10	2930
156.2	0.62	<5	170	10	12	3270
157.0	0.64	<5	370	72	<10	2350
163.8	0.67	<5	780	61	<10	1970
L9-131.6	0.75	8	280	23	18	2450
142.8	0.83	8	510	30	<10	2010
153.6	0.65	<5	470	14	20	3080
159.7	0.74	<5	190	26	14	2140
168.8	0.69	<5	300	14	23	3000

TABLE 11. CONTINUED.

Sample	V	Y	Zn	Zr	La	Nd
L1-94.6	375	105	1490	<10	410	510
97.7	385	<10	1260	135	<15	65
101.2	320	250	780	<10	980	1170
107.3-6	420	55	1030	<10	100	240
112.6	380	160	610	<10	550	740
116.2	450	40	1030	55	30	210
123.9	375	195	940	<10	700	900
126.4	380	210	1020	<10	750	1010
130.3	410	200	1000	<10	670	930
134.3	350	205	900	<10	840	990
L2-153.0-2	240	420	310	<10	1790	1930
170.5-7	140	585	360	<10	2570	2710
176.3	260	295	580	<10	1210	1370
181.4	300	295	690	<10	1160	1340
186.35	305	190	900	<10	730	900
191.3	245	450	820	<10	2770	2250
195.4	280	390	800	<10	2550	2000
201.6	195	760	540	<10	4140	3630
L6-103.7	230	490	700	<10	4570	3130
120.65	190	470	960	<10	2590	2390
127.3	180	910	570	<10	4870	4360
133.5	90	1240	280	<10	5400	5130
137.3	180	540	700	<10	3000	2730
142.7	160	490	540	<10	2800	2530
146.3	210	60	820	170	830	420
150.6	230	200	870	<10	1400	1080
156.2	240	230	880	<10	1570	1240
157.0	250	160	880	<10	1140	900
163.8	260	130	850	200	1100	760
L9-131.6	300	200	1060	<10	1470	1070
142.8	250	160	870	340	1160	890
153.6	160	200	610	270	1240	1170
159.7	250	180	800	45	1420	1030
168.8	240	330	830	<10	1880	1760

PROPERTY DESCRIPTIONS

APAMAG MINES LIMITED [1955]

Parsons (1961) described the work by Apamag Mines Limited as follows:

"Early in 1955 Apamag Mines Limited drilled four holes, totalling 1,089 feet on a 27-claim block in the southeastern part of the area. A fifth hole of 1,041 feet, was completed in 1957. Twenty-two of these claims were previously held by Dominion Gulf Company who had covered them with a magnetometer survey. The claims were allowed to lapse. The holes are plotted on [Figure 3, Chart A]."

CHYKA MINES LIMITED [1954]

A distinctly circular, magnetically anomalous area exists as an outlier to the main Lackner Lake complex northeast of Hebden (Portage) Lake in Lackner Township. This anomalous area is 900 m in diameter. Parsons (1961) described the work by Chyka Mines Limited as follows:

"In 1954, Chyka Mines Limited made a ground magnetic survey of the area and tested it with 28 diamond-drill holes totalling 10,514 feet. This work was entirely within the Hebden (Portage) Lake complex.

"The drilling indicated that this magnetically anomalous area is underlain chiefly by ijolite. The ijolite consists of nepheline, pyroxene, and minor amounts of titanite, magnetite, apatite, calcite, and sulphides. In texture, it ranges from a fine-grained to a very coarse pegmatitic rock. Its contact with the surrounding gneiss is gradational; pyroxene, nepheline, and minor titanite and calcite have formed in fractures and along the foliation of the contacting gneisses.

"Although the magnetic anomaly is distinctly circular, its internal pattern is extremely erratic, with variously oriented linear, as well as crescent-shaped, anomalies. Drilling indicates that these zones are ijolite, partly to completely replaced by biotite, magnetite, and calcite."

CLAYMAC MINES LIMITED [1955]

Parsons (1961) described the work by Claymac Mines Limited as follows:

"Claymac Mines Limited held 30 claims in Lackner Township on the north and northeast flank of the complex. They completed a ground magnetometer survey, and nine drill holes, totalling 2,722 feet in 1954. By 1958 the claims had been reduced to eight, all on the northeast flank.

"The magnetometer survey located only one anomaly of any linear extent; this was tested by three holes (Nos. 5, 6 and 7). The anomaly is due to a fine-textured, foliated ijolitic unit bordered by nepheline syenite. The highest Nb_2O_5 content was in hole No. 6, which averaged 0.13 percent from 203 to 274 feet."

DOMINION GULF COMPANY [1954]

Parsons (1961) described the work by Dominion Gulf Company as follows:

"In 1951 Dominion Gulf Company completed an aeromagnetic survey covering the alkalic rock complex, and staked 30 claims on the east flank of this area in Lackner Township. In 1952 they carried out a geological and a magnetic survey of these claims, and in 1954 carried out additional geological and magnetic studies and completed three diamond drill holes totalling 2,008 feet.

"This work indicated that weak linear magnetic anomalies are associated with foliated, intermediate to mafic, alkalic rocks, and strong, isolated anomalies are associated with granular apatite-magnetite pods and bodies in nepheline syenite. Hole No. 1, which tested the strongest and largest anomaly of the latter type, cut 200 feet of almost massive apatite-magnetite, from 400 to 600 feet in the hole. This material averaged 39.0 percent Fe (soluble), 5.0 percent P (37.0 percent apatite) and 0.15 percent Nb_2O_5, (Assessment Files Research Office, Ontario Geological Survey). A mafic envelope surrounding this body gave slightly higher assays in niobium. Magnetic data indicated that the body was too small to warrant further testing, and the claims were allowed to lapse.

"Hodder (1961) reported that the company estimated the width of this body as 75 to 100 feet and that the rocks on either side of the body contain pyrochlore over widths at 25 to 50 feet. The average Nb_2O_5 content was estimated as 0.15 percent."

FALCONBRIDGE NICKEL MINES LIMITED [1959]

Falconbridge Nickel Mines Limited staked 19 claims in the southeast corner and along the southern margin of the complex. The company completed 14 diamond drill holes totalling 3,336 feet on this group. The company also completed some ground magnetic surveys to fill in gaps of the earlier survey by Dominion Gulf Company. The main emphasis of the program was to locate high grade apatite and magnetite deposits.

Six diamond drill holes in the southeast corner of the complex outlined two small bodies of magnetite–apatite. One of these zones had been previously drilled by the Dominion Gulf Company.

In conjunction with the search for magnetite–apatite accumulations Falconbridge analyzed numerous syenite samples for their alumina content. Most assays ranged between 8 and 14 percent alumina (Naldrett 1959). The best assay was 16.86 percent alumina for samples taken from hole number 11 (Naldrett 1959). The possible presence of 4,000,000 tons of ceramic grade nepheline syenite was suggested in a memorandum by A.D. Mutch, Research Geologist for Falconbridge Nickel Mines Limited, which accompanied the report by Naldrett (1959), The memorandum did not specify the location of this nepheline syenite other than it was on the company's property. The grade was below that required by the company and interest in the property was terminated.

The company saved most of the core from its drilling of magnetite–apatite bodies on the Lackner Lake Alkalic Rock Complex. The author was permitted to examine and sample this core. Chemical and petrographic analyses of a selected group of the core samples are given in Appendix A. The analysed samples were taken from homogenous sections of the core.

Thin sections show that medium– to coarse–grained nepheline syenite occurs more distal to the apatite–magnetite. These syenites are typical of Unit 5c (coarse–grained inequigranular, leucocratic nepheline syenite). The feldspars have well developed perthitic textures.

Closer to the mineralized zones, the rocks are finer grained, richer in sodic pyroxenes, and have a granoblastic texture. The composition of these rocks is mafic nepheline syenite or malignite.

In close association with the magnetite–apatite veins the rock is feldspar–poor and has the composition of ijolite. The mafic minerals, mostly aegirine–augite, constitute nearly half of the rock and nepheline forms most of the remainder. The texture is fine grained and granoblastic.

Thin section examination suggests that sodium–iron metasomatism accompanied magnetite–apatite veining and that the coarse–grained syenite has been reconstituted through metamorphic–metasomatic processes into a fine–grained mafic rock that displays metamorphic textures. Extensive chemical analyses of these core samples would likely display all gradations in composition between nepheline syenite and ijolite.

A selected group of magnetite–apatite samples was submitted for spectrographic analysis by the Geoscience Laboratories, Ontario Geological Survey. The results are given in Table 11. For the elements tested, concentrations are not of economic interest.

MACDONNELL–LEBRASSEUR–DERRAUGH [1952]

The description of this property is taken from Parsons (1961).

"Three privately incorporated companies, LeBrasseur Lackner Incorporated, Derraugh Lackner Incorporated, and MacDonnell Lackner Incorporated, were formed by Buffalo, N.Y., interests on claims around and east of the fire tower in Lackner Township. These interests at present hold six patented claims (S.53643–45, S.54097–98, and S.54101). Initially they also held four surveyed claims (S.58584–87). They completed a magnetometer survey, and in 1952 drilled four holes totalling 1,007 feet to locate the cause of the higher magnetic anomalies. This work was done before interest developed in niobium, and no work has been done since.

"Rock outcrops are fairly plentiful, and the claims cover the foliated rocks on the north flank that are a potential location for niobium mineralization. Small highly radioactive pods of

apatite and magnetite have been noted by the author, and samples taken by him assayed up to 1 percent Nb_2O_5. In addition, narrow pyrochlore-bearing syenite dikes are present. A body of granular calcite and yellow garnets is indicated by boulders and a few outcrops; however, the niobium content of this body would appear to be quite low."

The Dominion Gulf Company Limited examined the claim group in 1955 (Parsons 1955).

MULTI-MINERALS LIMITED [1953 - PRESENT]

Parsons (1961) described the early work by this company as follows:

"Multi-Minerals Limited held 51 patented claims covering most of the west flank of the complex. These claims included a group previously held by Nemegos Uranium Corporation, which optioned them to Northrim Exploration Company in 1953; this company in the same year sold them to Multi-Minerals Limited.

"Magnetic and geological surveys and 99,154 feet of diamond drilling had been completed by the end of 1958. Metallurgical extraction tests were made on the magnetite-apatite as well as on the niobium-bearing bodies.

"The magnetic anomalies were numbered by the company, and associated mineralized zones were given the same numbers; these numbers have been retained in this report."

In 1970 Multi-Minerals Limited Zone No. 6 was optioned to Fetio Industrial Developments Limited for an evaluation of possible production of iron-titanium and phosphate concentrates (Canadian Mines Handbook 1972-1973, p.232). The company produced approximately 1,500 tons of concentrate which was shipped to the United States for metallurgical testing (personal communication, H.A. Pearson, formerly Vice-President Exploration, Multi-Minerals Limited).

Option arrangements with Fetio Industrial Development Limited terminated in December, 1973, and the entire property was subsequently optioned to Mertec Resource Development Limited in March, 1974 (Canadian Mines Handbook 1975-1976, p.232-233). The option arrangement with Mertec was terminated in May, 1975 (Canadian Mines Handbook, 1975- 1976, p.190).

Control of the Multi-Minerals Limited holdings passed to a new group in late 1976 headed by M. Burton, President (personal communication, H.A. Pearson, Multi-Minerals Limited, 1976).

During 1978-1979 Multi-Minerals Limited drilled 6 holes totalling 2,176 feet to test the uranium potential of various mineralized zones outlined by previous work. The results of this program are given in Table 12.

In hole No. 3, thorium was analyzed for in the section from 105.0 to 110.0 feet and a value of 0.300 pounds per ton was reported (Kidd 1979).

TABLE 12. ASSAYS FOR URANIUM AND NIOBIUM IN VARIOUS MINERALIZED ZONES AT LACKNER LAKE (FROM KIDD 1979).

Hole	Section (feet)	Length (feet)	Zone	U (lb/ton)	Nb (%)
1	284.0-304.0	20.0	6	0.075	-
2	184.0-204.0	20.0	6	0.045	-
3	33.0-335.0	317.0	8	0.095	0.16
4	225.0-235.0	10.0	-	0.572	0.575
5	115.0-135.0	20.0	1&2	0.15	-
	165.0-201.2	36.2	-	0.0164	-
6	-	-	-	-	-

Notes.
U analysis by neutron activation.
Nb analysis by X-ray fluorescence.

Hole no. 6 cut a breccia zone from 314.0 to 332.0 feet containing approximately 10 percent pyrrhotite, pyrite and chalcopyrite which returned a trace of gold, 0.023 ounces silver per ton, and 0.0286 percent copper (Kidd 1979).

Multi-Minerals Limited outlined several zones of mineralization in the Lackner Lake complex. Diamond drill core and exposures of these zones available to Parsons (1961) are no longer available for examination, therefore Parsons descriptions are presented here:

"Nos. 3, 4, and 5 Anomaly Zones

"This is an anomalous area about 3,000 feet long, consisting of two main linear anomalies, which appear to terminate at both ends in strong cross faults. This 3,000-foot length is also indicated to be divided into three sections by two more faults with several hundred feet of horizontal displacement. The locations of the mineralized zones are shown on [Figure 3].... [Figure 6] is a vertical cross-section through No. 3 and No. 4 zones.

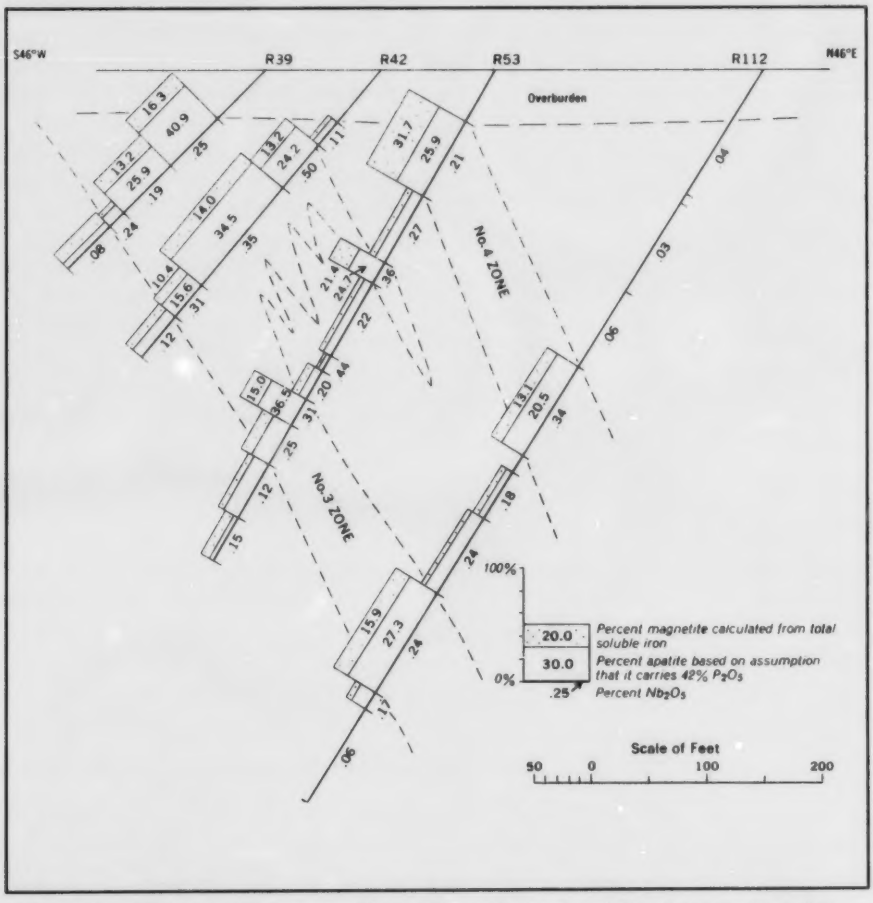

Figure 6. ***"Vertical section across Multi-Minerals' No. 3 and No. 4 zones. Note that the niobium mineralization is associated with the same general zone as the apatite-magnetite mineralization, but the niobium content is not directly proportional to the amount of that mineralization. Assays supplied by Multi-Minerals Limited." Reproduced from Parsons (1961, p.62).***

"Company officials estimated in their annual report for 1955 that the No. 3 and No. 4 zones contain 10,000,000 tons grading 15.5 percent magnetite, 19.5 percent apatite, and 0.23 percent Nb_2O_5.

"The mineralization is essentially apatite replacing foliated to massive, dark-green ijolitic rock. Sufficient magnetite accompanies the apatite to cause magnetic anomalies of several thousand gammas above the neighbouring areas. The pyrochlore is readily visible in the medium-grained ijolite, between sections rich in apatite. It occurs as finely disseminated grains and along irregular seams, without any apparent alteration of the adjacent rock. Visually, there is little apparent macroscopic difference between the ijolitic rocks of the higher-grade niobium zones and the ijolites in the hanging wall, except possibly the former are less foliated and more massive.

"In some of the holes penetrating well into the footwall of the southern part of the zone, there is evidence that these rocks are pyroxenitized or partly pyroxenitized gneiss, which is in turn underlain by nepheline syenite. The footwall of the northern part of the zone is nepheline syenite.

"No. 6 Body

"This body is a very uniform mass of granular magnetite and apatite. It has been thoroughly tested and outlined by diamond-drilling. It strikes northwest and dips more or less vertically. It has a maximum length of 800 feet and a maximum width of 200 feet, and tapers to a point at a vertical depth of between 400 and 500 feet below surface [Figures 7 and 8]. Company officials estimate that it contains 5,000,000 tons grading 70 percent magnetite, 22 percent apatite and 0.17 percent Nb_2O_5. The magnetite is titaniferous; the niobium mineral has been identified as pyrochlore, and the mineralization is quite radioactive. In addition to these minerals, there is a small amount of pyroxene and pyrrhotite. Occasionally massive veins and spots of magnetite, as well as seams of pure apatite, occur in the granular-type mineralization.

"The rocks surrounding the body are chiefly ijolitic types ranging from a rather uniform to the very blotchy types previously described as ijolite rock type 3a. Some of the syenite that alters to this ijolite type occurs on the south side. A syenite dike occurred in the body near the east wall of the pit, but the evidence was not clear as to whether it cut the apatite-magnetite mass or was a pre-existing dike that was not replaced. The walls of the massive mineralization are sharp, even when there is no evidence of faulting along a contact.

"All the diamond-drill holes passing through the body at depth along the west and northwest sides, of which fourteen were examined, passed into a different mineralogical zone from that surrounding the body. This disclosed an abrupt termination of the magnetite mineralization (mostly as veins) common to ijolite rock type 3a, and the appearance of titanite. This titanite-bearing and magnetite-free zone appears directly correlatable with similar rocks exposed in the Multi-Minerals camp area, and on the high ground to the southwest of No. 6 body. It is essentially a leucocratic, feldspathic, and gneissic rock with locally mafic-rich bands and areas, and cut by mafic dikes. The mafic rocks range from pyroxene-rich to biotite-rich, mostly with varying concentrations of titanite. All these types are cut by coarse-grained nepheline syenite masses and associated stringers and dikelets. Apatite is common and locally plentiful in some of the blocks of gneiss in these syenites. A similar condition was noted on the east flank of the complex, where definite blocks and fragments of gneiss are caught up in nepheline syenite. This same area also has pods and small bodies of massive magnetite and apatite in the nepheline syenite.

"Pyrochlore Zone in Wall of No. 6 Body

"About 200 feet south of No. 6 body, there is an outcrop of ijolite breccia cut by numerous nepheline-filled fractures carrying considerable pyrochlore. Company officials estimate, from five drill holes, there are 2,000,000 tons of possible ore grading 0.28 percent Nb_2O_5.

[A non-representative grab sample collected by the author from the number 6 Zone returned 75.5 percent Fe_2O_3, 16.6 percent FeO, 5.25 percent P_2O_5 and 3.10 percent TiO_2. Analysis by Geoscience Laboratories, Ontario Geological Survey.]

"No. 8 Zone

"This is predominantly a silicate-type niobium-bearing zone. It lies north of the No. 6 massive apatite-magnetite zone. It has been diamond-drilled along a 1,500-foot length to vertical depths of about 1,100 feet. True widths of up to 1,000 feet averaging slightly over 0.25 percent Nb_2O_5 are indicated. In this zone there are higher grade sections averaging about 0.33

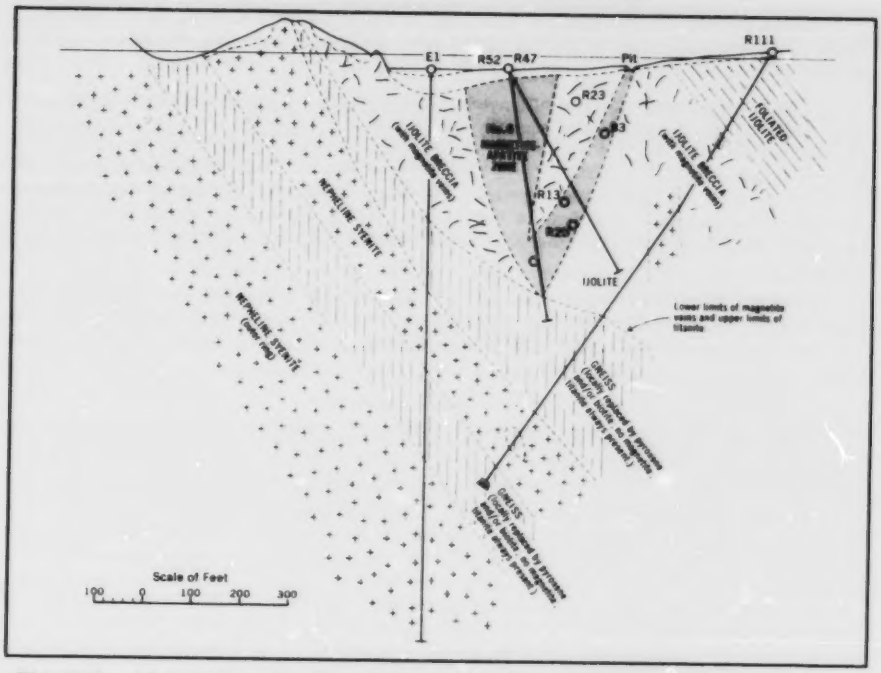

Figure 7. *"A vertical section through the centre of Multi-Minerals Limited No. 6 massive apatite-magnetite body...." Reproduced from Parsons (1961, p.64).*

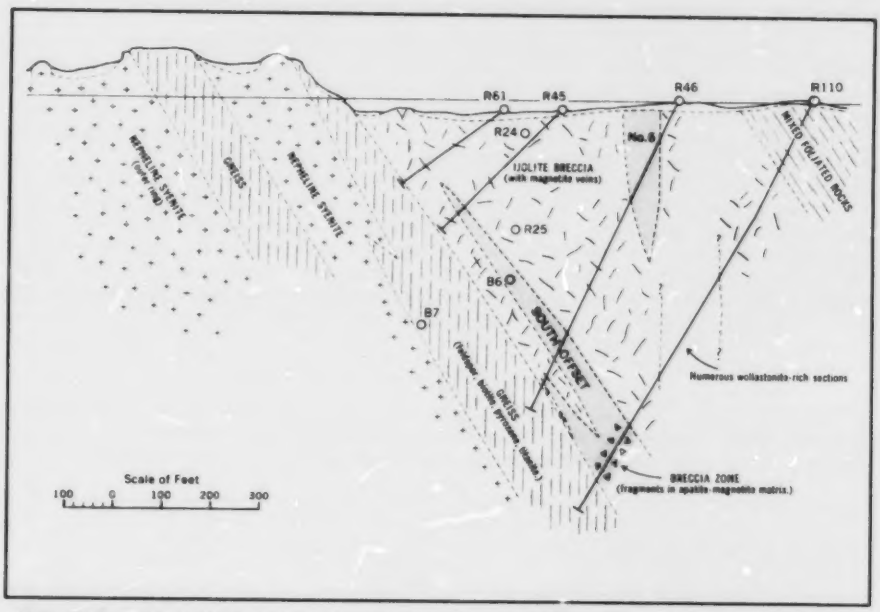

Figure 8. *"A vertical section through the east end of Multi-Minerals Limited No. 6 massive apatite-magnetite body...." Reproduced from Parsons (1961, p. 65).*

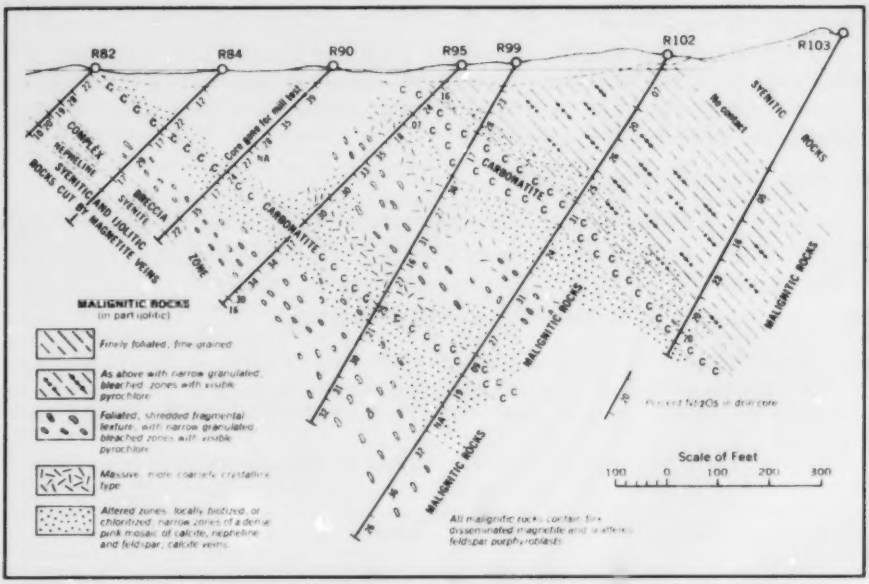
R82
R84
R90
R95
R99
R102
R103
COMPLEX NEPHELINE SYENITIC AND IJOLITIC ROCKS CUT BY MAGNETITE VEINS
BRECCIA ZONE
Core loss for mill test
CARBONATITE
CARBONATITE
MALIGNITIC ROCKS
MALIGNITIC ROCKS
MALIGNITIC ROCKS
No contact
SYENITIC ROCKS
MALIGNITIC ROCKS (in part ijolitic)
Finely foliated, fine grained
As above with narrow granulated, bleached zones with visible pyrochlore
Foliated, shredded fragmental texture with narrow granulated, bleached zones with visible pyrochlore
Massive, more coarsely crystalline type
Altered zones, locally bleached, or chloritized, narrow zones of a dense pink mosaic of calcite, nepheline and feldspar, calcite veins
Scale of Feet
100 0 100 200 300
All malignitic rocks contain fine disseminated magnetite and scattered feldspar porphyroblasts

Figure 9. ***"A vertical section through Multi-Minerals Limited No. 8 niobium zone. Assays from company plans supplied by Multi-Minerals Limited." Reproduced from Parsons (1961, p.66).***

percent Nb_2O_5 over widths up to 200 feet wide. These higher-grade sections are mainly found in the central and footwall parts of the zone. A vertical section, showing the individual Nb_2O_5 assays and some of the macroscopically visible features evident in the core, is presented in [Figure 9].

"This zone lies in rocks classed as foliated types and dips at 45-160 degrees inward with them. The rocks in the zone generally range from a malignite to an ijolitic malignite in composition. However, in addition to feldspar, pyroxene, and nepheline, they also contain magnetite, apatite, calcite, zircon, sulphides, and pyrochlore. The magnetite occurs as finely disseminated grains or aggregations throughout the zone but never occurs as veins. Feldspar porphyroblasts are generally present. A foliated, finely fragmental fabric is very characteristic of the zone ... however, coarse-grained, more granitoid, massive types are also present.

"The higher-grade niobium values are mostly associated with more granulated sections with shred-like fragments and altered streaks, which have a pale grey or straw-yellow cast. Fine pyrochlore is normally visible along these streaks; it also occurs as scattered grains throughout the zone.

"Two carbonatite dikes are present in the zone. The upper one has been extensively drilled as a carbonate-type orebody and is described below as the 'calcite zone'. On both sides of these dikes the host rocks contain other narrow carbonatite 'dikelets' and calcite veins. In addition, there are dense, pink altered zones consisting of a fine-grained mosaic of nepheline, and feldspar with or without calcite. Biotite is also abundant. The evidence does not indicate that this alteration is accompanied by an increase in niobium, in fact, it may cause a slight dilution of the niobium content.

"Calcite Zone

"This is the company's designation for the carbonatite dike mentioned above. It has been drilled along a 500-foot length, and it pinches and bulges along that length as well as in dip. The greatest true width encountered was 100 feet. The indicated grade is variable, but may average slightly under 0.20 percent Nb_2O_5. The character of the zone has been described in the section on carbonatites. The typical distribution of the pyrochlore in this zone is shown in [Figure 9]. Company officials report that tests indicate a pyrochlore concentrate can be produced from this material by simple mechanical means."

MULTIWIN EXPLORATIONS LIMITED [1954]

Multiwin Explorations Limited completed an aeromagnetic survey and drilled 7 holes totalling 1,450 feet on claims S62700 to S62753 inclusive and claims S62557 to S62562 inclusive, along the western boundary of the complex. Nothing of economic interest was encountered.

NANECK MINES LIMITED [1950]

Naneck Mines Limited completed a magnetometer survey over claims S56527 to S56344 inclusive located near the southwestern boundary of the complex. No further work is reported.

ONTARIO RARE METAL MINES LIMITED [1954]

The description of this property is taken from Parsons (1961).

"In 1954-55, this company completed a magnetometer survey, and five diamond-drill holes totalling 2,281 feet, on twenty-seven claims in the southeastern part of McNaught Township.

"This work indicated that the claims were underlain by gneisses and cut by northerly-trending diabase dikes. In the area of holes Nos. 1-4, the magnetic data indicate many faults trending in a northeasterly direction, near which there are many isolated small magnetic highs. The drill holes encountered much faulting as well as gabbroic rocks. The gneisses that were cut in the drill holes are locally reddened and pyroxenitized, or biotitized, or both. They are also cut by numerous mafic dikes. Only traces of niobium were obtained in assays of the core."

M. SILVERMAN CLAIMS [1954, 1959]

The description of this property is taken from Parsons (1961).

"This group consists of sixty-eight claims in the southern part of Lackner Township and the southeastern part of McNaught Township. In 1954 a magnetometer survey, and fourteen drill holes, totalling 4,117 feet, were completed. This group is situated immediately south and east of the Multi-Minerals group.

"The magnetometer survey indicated several anomalous areas on the east and south flanks of the alkaline complex. These anomalous areas were tested by short drill holes ...[see Figure 3, Chart A].

"Hole No. 9 indicated that the anomaly in that area is due to magnetite in nepheline syenite; hole No. 10 indicated this anomaly to be caused both by mafic rocks and magnetite veins. The rest of the drilling indicated that the anomalies were mostly due to mafic bands bordered by nepheline syenite.

"The niobium analyses obtained from the split core ranged up to a maximum of 0.29 percent Nb_2O_5 over 5 feet, but the more mafic foliated rocks generally ranged from 0.07 to 0.14 percent Nb_2O_5 according to information supplied by M. Silverman."

In 1959 M. Silverman completed an additional 20 diamond drill holes totalling 2,941 feet. A large number of these holes were abandoned in overburden and the others encountered micaceous gneisses (Assessment Files Research Office, Ontario Geological Survey, Toronto).

UNION CARBIDE CANADA MINING LIMITED [1969]

Union Carbide Canada Mining Limited drilled an 801-foot hole on claim S155436 located approximately 2,300 feet north of the north end of Lackner Lake. The core is reported to consist of coarse-grained nepheline syenite cut by two lamprophyre dikes from 222 to 228 feet and 490 to 493 feet. No further work is reported.

RECOMMENDATIONS TO THE PROSPECTOR

Extensions to some of the mineralized zones of Multi-Minerals Limited, principally Zone 8, appear to be possible. Large or additional deposits of massive mag-

netite and apatite such as Multi–Minerals Zone 6 and perhaps deposits similar to the two small deposits located by Falconbridge Nickel Mines Limited in the southeast portion of the complex are not likely to be found because any magnetic anomalies of potential interest have already been drill tested. Small lenses and dikes of magnetite and apatite are not uncommon but are not likely to form sufficient tonnage to make an ore body.

The large tonnages of low grade niobium mineralization found within the mafic phases of the intrusion will probably be of value in the near future but higher grade deposits in other areas of Ontario and Quebec and outside Canada are likely to be extracted first. The greatest potential for an economically viable operation would be the development of an economic process that would recover several commodities from the same ore, i.e., apatite, magnetite, nepheline, rare earth elements and pyrochlore. Leucocratic nepheline–rich areas within the nepheline syenite should by delineated and checked for the possible recovery of their alumina content.

Appendix A — Petrographic Descriptions, Chemical Analyses and Normative Compositions of Samples from the Lackner Lake Alkalic Rock Complex.

TABLE A-1. PETROGRAPHIC DESCRIPTIONS OF WHOLE-ROCK SAMPLES* FROM THE LACKNER LAKE ALKALIC ROCK COMPLEX.

Reference No. 845
Sample No. LW12-1

Nepheline syenite.

Field Description. Coarse grained, massive, equigranular. Colour index 5 to 10. Very weak trachytoidal texture. Weathered surfaces are pinkish grey, fresh surfaces reddish brown. Map-unit 5c.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Very minor dark green aegirine-augite is present. Biotite forms scattered dark brown grains and commonly rims magnetite, amphibole, and pyroxene. Amphibole is minor; it thickly mantles pyroxene and may in turn be rimmed by biotite. Nepheline forms anhedral to subhedral grains, interlocking with potassium feldspar and in places enclosed in potassium feldspar. Nepheline shows minor alteration to cancrinite. Perthite forms anhedral to subhedral grains with Carlsbad twinning. Stringy perthite texture is evident at high magnification. Minor albite has developed along grain boundaries.

Reference No. 846
Sample No. LW12-2

Nepheline syenite.

Field Description. Coarse grained, massive, equigranular. Colour index 5 to 10. Weathered surfaces are pink to grey, fresh surfaces reddish brown. Map-unit 5c.

Petrographic Description. Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Minor disseminated magnetite is present. Minor interstitial biotite commonly rims magnetite. Potassium feldspar forms subhedral to anhedral grains with some Carlsbad twinning; the development of faint stringy texture is evident at high magnification. Nepheline forms anhedral grains interlocking with potassium feldspar; it is moderately altered to cancrinite. Albite has developed along grain boundaries and grain margins of potassium feldspar.

Reference No. 847
Sample No. LW22-1

Biotite ijolite.

Field Description. Fine grained, schistose, equigranular with occasional small feldspar phenocrysts on the outcrop surface. The outcrop is cut by a coarse grained syenite dike, but the sample collected for analysis is homogeneous. Weathered and fresh surfaces are black. Map-unit 4a.

Petrographic Description. Fine grained, schistose, equigranular, allotriomorphic, with curved to straight grain boundaries. Garnet forms brown anhedral grains. Pyroxene is anhedral, irregularly shaped aegirine-augite. Biotite forms anhedral to subhedral grains interlocking with pyroxene. Biotite contains poikilitic apatite and encloses some pyroxene. Anhedral grains of nepheline form an interlocking mosaic. Tiny rounded poikilitic inclusions are common in centres of nepheline grains. Texture is weakly granoblastic.

**Reference numbers for outcrop samples are plotted on Figure 3 (Chart A). Sample numbers prefixed with* LAC *are drill core samples from Multi-Minerals holes (locations of core unknown). Sample numbers prefixed with* L1 *to* L13 *are drill core samples from Falconbridge Nickel Mines holes (FN series holes on Figure 3).*

Reference No. 848
Sample No. LW22-2

Biotite ijolite.

Field Description. Fine to medium grained, massive, inequigranular-seriate. Locally dikes and dikelets cut the outcrop and blebs of biotite, nepheline and feldspar are common. Locally the rock is weakly foliated. The sample was taken from homogeneous area of outcrop. Traces of carbonate occur along joint surfaces. Weathered surfaces are grey, fresh surfaces dark grey. Map-unit 4a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Biotite forms brown anhedral crystals interlocking with pyroxene. Pyroxene is an anhedral aegirine-augite. Apatite forms subhedral to euhedral grains. Nepheline is fresh, anhedral, and interlocks with pyroxene; it contains tiny poikilitic inclusions of aegirine-augite.

Reference No. 849
Sample No. LW22-4B

Nepheline - aegirine-augite syenite or malignite.

Field Description. Medium grained, massive, inequigranular-porphyritic-seriate. Feldspar phenocrysts up to 8 mm in length form 10 to 15 percent of rock. The rock is weakly gneissic with discontinuous mafic streaks. Weathered and fresh surfaces are pink. Map-unit 5a.

Petrographic Description. Fine to medium grained, equigranular, allotriomorphic with curved to straight grain boundaries. Pyroxene is a green to dark green aegirine-augite; the grains are rounded and anhedral and contain the occasional rounded bleb of nepheline. Nepheline forms anhedral, fresh grains; some of the larger grains contain a ring of inclusions consisting of bead-like grains of aegirine-augite and possibly nepheline of different optical orientation than the host grain. Perthite forms an interlocking mosaic of grains containing ring-like zones of inclusions of aegirine and possibly nepheline. Perthite is stringy.

Reference No. 850
Sample No. LW22-5

Biotite - pyroxene nepheline syenite.

Field Description. Medium grained, inequigranular-seriate, massive. Mafic minerals are locally somewhat clotty. Weathered surfaces are grey, fresh surfaces grey pink. The syenite is somewhat darker grey in colour than usual. Map-unit 5a.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Pyroxene is a green aegirine-augite, anhedral in outline; it locally encloses rounded blebs of nepheline. Cores of pyroxene are slightly paler than rims. Biotite forms brown anhedral to euhedral grains. Nepheline forms anhedral to subhedral crystals, with patchy alteration along cleavages. Staining test shows potassium is present in alteration areas. Perthite forms anhedral grains with Carlsbad twins and faint stringy perthite texture.

Reference No. 851
Sample No. LW22-7

Biotite - pyroxene nepheline syenite.

Field Description. Medium grained, massive, inequigranular-porphyritic-seriate. Feldspar phenocrysts, up to 8 mm in length, have a seriate distribution and form 10-15 percent of rock. On slabbed surface, the rock is weakly trachytoidal. Weathered surfaces are buff, fresh surfaces pink. Outcrop surface contains the occasional biotite grain 1 to 1.5 cm in diameter. Map-unit 4c.

Petrographic Description. Fine grained, gneissic, inequigranular-seriate, allotriomorphic, with curved grain boundaries. Mafic minerals are clotty, defining a gneissosity; locally fine-grained areas have granoblastic texture. Biotite forms anhedral, irregular grains enclosing pyroxene, nepheline, and magnetite. Pyroxene forms anhedral, irregular grains of aegirine-augite. Perthite is anhedral and interlocking with nepheline. Nepheline is anhedral, fresh, and interlocking with perthite. Circular to elliptical zones of inclusions occur in larger nepheline and perthite grains. Variation in extinction across inclusion zones suggests two periods of growth.

Reference No. 852
Sample No. LW22-8

Amphibole - biotite - aegirine-augite nepheline syenite or malignite.

Field Description. Medium grained, massive, equigranular. Scattered fine-grained ijolitic xenoliths up to 5 cm long and 2 cm wide are present. Several small 1 cm long xenoliths were removed from the sample by diamond saw before analysis. Weathered surfaces are pinkish brown, fresh surfaces pink. Map-unit 5a.

Petrographic Description. Fine to medium grained, equigranular to inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Biotite forms anhedral brown grains rimming pyroxene and amphibole. Amphibole is dark greenish brown, in part replacing pyroxene. Nepheline forms anhedral, irregular grains interlocking with perthite; nepheline contains the occasional biotite and apatite inclusion. Perthite is string type, interlocking with nepheline. Pyroxene is pleochroic in green, and is altering to biotite and amphibole.

Reference No. 853
Sample No. LW22-9

Biotite - pyroxene nepheline syenite.

Field Description. Medium grained, equigranular, massive. In outcrop the rock contains mafic xenoliths. Weathered surfaces are buff, fresh surfaces pink. Map-unit 5a.

Petrographic Description. Medium grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Pyroxene is an anhedral, irregular, green aegirine-augite; grains have slightly paler green cores and may contain poikilitic inclusions of apatite, biotite and carbonate. Biotite forms anhedral grains interlocking with pyroxene. Perthite forms anhedral grains with stringy texture; some grains have vestiges of albite twinning along rims, and some grains are patch perthite (antiperthite) (An6-11). Nepheline is anhedral and fresh; rounded blebs of nepheline occur in potassium feldspar. Circular to elliptical zones of pyroxene and apatite inclusions occur in feldspar and nepheline.

Reference No. 854
Sample No. LW22-10

Nepheline - aegirine-augite syenite or malignite.

Field Description. Medium grained, massive, equigranular. In outcrop the rock contains the odd larger (>1 cm) biotite crystal. Weathered surfaces are brown, fresh surfaces pink. Map-unit 4a.

Petrographic Description. Fine to medium grained, massive, equigranular to inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. Pyroxene is anhedral, irregular aegirine-augite with rare poikilitic magnetite and minor alteration to biotite. Nepheline forms irregular grains; large grains have a ring of inclusions of pyroxene and possibly apatite. Potassium feldspar is anhedral perthite and is interlocked with nepheline. Ring-like zones of inclusions in feldspar consist of bead-like grains of aegirine-augite and possibly nepheline.

Reference No. 855
Sample No. LW22-11

Ijolite.

Field Description. Medium grained, massive, equigranular. Mafic minerals tend to be slightly clotty. The clots are located randomly and some may or may not be partially assimilated xenoliths. The sample taken for analysis was the most homogeneous available and should be representative. Weathered surfaces are mottled grey and black, fresh surfaces are pink and black. Map-unit 4a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Sphene forms subhedral to anhedral grains and may enclose pyroxene. Biotite forms anhedral, irregular brown grains; larger grains may enclose pyroxene. Pyroxene forms anhedral to subhedral grains, zoned with pale green cores and green rims. Generally fresh grains of nepheline form an interlocking mosaic; traces of cancrinite alteration are present.

Reference No. 856
Sample No. LW22-12A

Nepheline - aegirine-augite syenite or malignite.

Field Description. Medium grained, massive, inequigranular-porphyritic-seriate. Feldspar phenocrysts up to 6 mm in length form 10 to 15 percent of rock. Weathered surfaces are mottled pink and black, and fresh surfaces are pinkish. Map-unit 4b.

Petrographic Description. Fine to medium grained, equigranular, allotriomorphic, with curved to straight grain boundaries. Magnetite forms anhedral disseminated grains. Pyroxene is an anhedral aegirine-augite. Nepheline forms anhedral to subhedral grains; larger grains contain a ring of small bead-like inclusions near periphery of grain. Inclusions are aegirine-augite, possibly some apatite. Cancrinite irregularly replaces nepheline. Perthite is string type, forming anhedral grains interlocking with nepheline. Carlsbad twinning and the occasional poikilitic inclusion of aegirine-augite are present in the perthite. Albite (An8) forms anhedral, tabular crystals interlocking with potassium feldspar and nepheline.

Reference No. 857
Sample No. LW22-13

Amphibole - pyroxene nepheline syenite or malignite.

Field Description. Medium to coarse grained, equigranular, porphyritic-seriate. Feldspar phenocrysts up to 2 cm in length compose about 20 percent of rock. Some magnetite is evident in outcrop. Outcrop displays a moderately trachytoidal texture. Weathered surfaces are dark grey and fresh surfaces dark grey. Map-unit 4a.

Petrographic Description. Fine to medium grained, inequigranular-porphyritic-seriate, allotriomorphic, with curved to straight grain boundaries. Apatite occurs as euhedral crystals poikilitic in pyroxene and amphibole. Pyroxene is pale green aegirine-augite, which is thickly rimmed with dark greenish-brown amphibole. Pyroxene poikilitically encloses apatite and more rarely magnetite. Magnetite forms anhedral disseminated grains. Amphibole is a dark greenish-brown and mantles pyroxene. Amphibole also occurs as a patchy alteration on pyroxene. Nepheline is fresh and forms anhedral irregular grains interlocking with potassium feldspar. Rarely nepheline contains poikilitic pyroxene. Potassium feldspar is anhedral, string perthite, which rarely contains anhedral poikilitic nepheline. Phenocrysts are potassium feldspar with Carlsbad twinning, merging with finer grained perthite of the groundmass.

Reference No. 858
Sample No. LW22-15

Biotite - amphibole nepheline syenite.

Field Description. Coarse grained, massive, equigranular, homogeneous. Colour index 20 to 25. Weathered surfaces are mottled pink and black and fresh surfaces mottled pink and black. Map-unit 5c.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Biotite forms brown anhedral to subhedral grains in association with amphibole. Pyroxene forms several rounded grains of aegirine-augite, and is mantled with amphibole. Amphibole is deeply pleochroic in green to brownish-green and is anhedral. The amphibole is likely a high-sodium-iron variety. Nepheline forms anhedral to subhedral grains, which are generally fresh. Perthite forms anhedral, irregular grains with weak stringy texture. Some rounded blebs of nepheline occur in the perthite.

Reference No. 859
Sample No. LW22-16

Biotite - amphibole nepheline syenite.

Field Description. Coarse grained, massive, equigranular. Weathered surfaces are pink, fresh surfaces pink. Colour index 5 to 10. Map-unit 5c.

Petrographic Description. Medium grained, equigranular, massive hypidiomorphic. Amphibole is pleochroic green, anhedral, and contains poikilitic pyroxene and magnetite. Amphibole is a sodium-iron variety. Pyroxene is anhedral aegirine-augite, associated with amphibole. Albite (An5-7) forms tiny anhedral grains which are intergranular to nepheline and perthite. Nepheline forms anhedral to euhedral grains which are poikilitic in or interlocking with perthite. Perthite is an anhedral to subhedral string perthite, in part enclosing, and in part interlocking with nepheline.

Reference No. 860
Sample No. LW22-16A

Biotite - pyroxene - amphibole nepheline syenite.

Field Description. Medium to coarse grained, massive, equigranular, homogeneous. Colour index 30 to 35. Weathered surfaces are pink to buff, fresh surfaces mottled pale pink and black. Map-unit 5c.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, allotriomorphic, with curved grain boundaries. Pyroxene is an aegirine-augite; it forms rounded anhedral grains mantled with amphibole. Amphibole is pleochroic green, and in part replaces pyroxene. Biotite forms brown anhedral grains in association with pyroxene and amphibole. Nepheline is anhedral, interstitial, and altered along cleavages to fine grained sericite (?). Orthoclase occurs as equant to tabular, anhedral grains, almost granoblastic in appearance.

Reference No. 861
Sample No. LW22-18

Pyroxene nepheline syenite or malignite.

Field Description. Fine to medium grained, equigranular to inequigranular-porphyritic seriate. Feldspar phenocrysts up to 6 mm in length are evident in outcrop. Weathered surfaces are grey, fresh surfaces grey. Map-unit 4a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Nepheline is anhedral, interlocking with feldspars, and fresh in appearance. Perthite is a fine stringy type, interlocking with nepheline. Larger grains interlocking with nepheline and feldspar have circular to elliptical zones of rounded inclusions of pyroxene and apatite.

Reference No. 862
Sample No. LW22-19

Pyroxene nepheline syenite.

Field Description. Fine to medium grained, inequigranular-porphyritic-seriate. Subhedral to euhedral feldspar phenocrysts are up to 8 mm long, and comprise 5 to 10 percent of rock. On a sawn surface, the rock appears weakly trachytoidal and weakly gneissic. Gneissosity is due to variation in mafic to felsic mineral ratios. Map-unit 4b.

Petrographic Description. Fine grained, massive to weakly foliated, equigranular, allotriomorphic, with curved to straight grain boundaries. The rock is not porphyritic in thin section. Texture appears granoblastic elongate. Pyroxene is a green, anhedral aegirine-augite. Nepheline forms fresh, anhedral grains interlocking with feldspars. Perthite is anhedral, and interlocking with nepheline. Perthitic texture is a very fine stringy type.

Reference No. 863
Sample No. LW22-20

Leucocratic pyroxene nepheline syenite.

Field Description. Fine grained, equigranular, massive. A few feldspar phenocryst are up to 0.2 cm long. Weathered surfaces are grey, fresh surfaces pinkish grey. Map-unit 5a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Plagioclase (An7-10) forms irregular grains and patches, undergoing patchy potassium feldspar replacement. Pyroxene is anhedral, irregular aegirine-augite. Nepheline forms larger, irregular amoeboid grains associated with angular to subangular grains of perthite and aegirine-augite. Perthite forms anhedral to subhedral grains with well developed stringy texture.

Reference No. 864
Sample No. LW22-22

Porphyritic, nepheline - pyroxene syenite or malignite.

Field Description. Fine to medium grained, massive, inequigranular-porphyritic-seriate. Feldspar phenocrysts up to 6 mm long form 10 to 15 percent of the rock. Weathered surfaces are dark grey, and fresh surfaces light grey to pink. Map-unit 4a.

Petrographic Description. Fine to medium grained, massive, inequigranular-porphyritic-seriate, allotriomorphic, with curved to straight grain boundaries. Potassium feldspar forms anhedral crystals, commonly in porphyritic relationship to groundmass. Larger feldspar grains and some of the smaller grains contain a ring of inclusions along the grain margin. Feldspar crystals have had adcumulus overgrowth, and may contain poikilitic nepheline. Carlsbad twinning is rare. Pyroxene is a dark green, anhedral aegirine-augite; some grains enclose or partially enclose nepheline and potassium feldspar. Nepheline forms fresh, anhedral crystals, with rings of inclusions along rims of grains. Inclusions are aegirine-augite.

Reference No. 865
Sample No. LW22-22A

Melanocratic nepheline syenite or malignite.

Field Description. Fine grained, massive, equigranular. Locally, the outcrop is foliated. Weathered surfaces are grey black, fresh surfaces black. Map Unit 4a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Biotite forms brown anhedral to subhedral grains which define a schistosity. Pyroxene is anhedral, irregular and associated with biotite. Poikilitic biotite, apatite, magnetite, carbonate, and nepheline occur in the pyroxene. Pyroxene crystals have pale green cores. Nepheline forms fresh anhedral grains interlocking with orthoclase. Orthoclase forms anhedral grains interlocking with nepheline, magnetite, biotite, pyroxene, nepheline. Texture is weakly granoblastic elongate.

Reference No. 866
Sample No. LW22-23

Pyroxene nepheline syenite.

Field Description. Fine to medium grained, massive to weakly gneissic, inequigranular-porphyritic-seriate. Feldspar phenocrysts up to 1 cm long, with a seriate distribution, may comprise

up to 5 percent of rock. Rock is weakly gneissic due to variation in mafic to felsic mineral ratios. The sample for analysis may be heterogeneous and not representative of the bulk composition of the rock. Weathered surfaces are light grey, fresh surfaces light grey. Map-unit 4b.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene is green, anhedral, and irregular. Perthite forms anhedral grains with well developed stringy texture. Perthite forms an interlocking mosaic. Nepheline forms anhedral grains interlocking with perthite. A circular zone of rounded blebs of pyroxene and apatite is found in the larger grains of nepheline and perthite. One large grain of feldspar has an orthoclase core, an inclusion zone, and a perthite rim.

Reference No. 867
Sample No. LW22-25

Biotite ijolite.

Field Description. Fine grained, equigranular. A few large feldspar phenocrysts are present, forming up to 1 percent of the rock. Weathered surfaces are grey, fresh surfaces black. Map-unit 4a.

Petrographic Description. Fine grained, massive, inequigranular-seriate, allotriomorphic, granoblastic with curved grain boundaries. Biotite forms brown, anhedral to subhedral grains which define a weak schistosity. Biotite also forms rounded aggregates containing cores of pyroxene and nepheline, similar in appearance to the nepheline and pyroxene outside the biotite. Pyroxene is anhedral aegirine-augite. Larger pyroxene grains contain abundant inclusions of biotite, and some nepheline. Nepheline forms fine grained anhedral mosaics; locally elliptical or circular clots of nepheline are coarser grained. Minor anhedral carbonate occurs interstitially. Rock has a metamorphic texture.

Reference No. 868
Sample No. LW22-26

Biotite - pyroxene nepheline syenite.

Field Description. Fine to medium grained, inequigranular-porphyritic. Feldspar phenocrysts up to 8 mm long, in seriate distribution, form 10 to 15 percent of the rock. Rock is weakly trachytoidal due to subparallel orientation of tabular feldspars. Weathered and fresh surfaces are pink to greenish pink. Map-unit 4b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Magnetite is anhedral and contains blebs of nepheline. Biotite forms anhedral grains of reddish brown colour, generally rimming magnetite. Pyroxene is an anhedral, irregularly shaped aegirine-augite with poikilitic inclusions of apatite and nepheline. Nepheline forms anhedral grains interlocking with perthite. Larger nepheline grains have a ring-like zone of poikilitic pyroxene and amphibole. Perthite is anhedral and stringy; larger grains have a circular zone of inclusions of pyroxene and apatite, and probably nepheline.

Reference No. 869
Sample No. LW22-29

Garnet-bearing, pyroxene nepheline syenite.

Field Description. Fine grained, equigranular, massive. Occasional biotite phenocrysts up to 0.3 cm in diameter and nepheline phenocryst up to 0.25 cm in diameter are seen in the outcrop. The sample for analysis contained no phenocrysts. Weathered surfaces are dark green, fresh surfaces dark grey. Map-unit 4a.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic to allotriomorphic, with curved grain boundaries. Pyroxene is anhedral to euhedral aegirine-augite. Nepheline is anhedral and contains poikilitic inclusions of aegirine-augite and magnetite. Traces of biotite are after pyroxene. Garnet forms anhedral brown grains in association with pyroxene. Feldspar is anhedral and dominantly orthoclase, but some grains have a stringy perthite texture at high magnification. Texture is weakly to moderately granoblastic.

Reference No. 870
Sample No. LW22-31

Amphibole - pyroxene nepheline syenite.

Field Description. Coarse grained, massive, equigranular. Colour index 10 to 15. Weathered and fresh surfaces are pink. Map-unit 5c.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Amphibole is pleochroic green, in part interlocking with or replacing aegirine-augite. Amphibole is a sodium-iron variety interstitial to feldspar and nepheline. Pyroxene is anhedral aegirine-augite,

interlocking with and in part replaced by amphibole. Perthite forms anhedral grains interlocking with nepheline. Stringy texture is well developed and some Carlsbad twinning is evident. Nepheline forms anhedral to euhedral grains interlocking with and enclosed within perthite.

Reference No. 872
Sample No. LW23-1

Melanocratic, biotite - pyroxene nepheline syenite.

Field Description. Medium to coarse grained, massive, but with some variation in mafic to felsic mineral ratios, imparting a slight inhomogeneity to the rock. Weathered surfaces are grey, fresh surfaces mottled pink and black. Colour index 25 to 30. Map-unit 5a.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Biotite forms reddish-brown anhedral grains, partially enclosing pyroxene and nepheline; it locally displays bent (001) cleavage. Pyroxene is aegirine-augite, forming anhedral to subhedral grains with pale green cores, and containing some poikilitic apatite. Orthoclase forms Carlsbad-twinned anhedral grains. At high magnification there is a weak suggestion of perthite texture. Nepheline is anhedral to subhedral and interlocking with feldspar.

Reference No. 873
Sample No. LW23-2

Biotite - pyroxene nepheline syenite.

Field Description. Medium to coarse grained, massive, equigranular. In outcrop the rock contains xenoliths of ijolite. Xenoliths have sharp contacts and there is no evidence of assimilation. Colour index approximately 35. Weathered surfaces are dark grey, fresh surfaces mottled pink and dark grey. Map-unit 5c.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Pyroxene is anhedral to subhedral aegirine-augite with pale green cores in larger grains. Biotite is poikilitic in one or two pyroxene grains. Biotite is reddish brown, anhedral, and associated with pyroxene. Biotite partially encloses nepheline and pyroxene. Perthite forms anhedral, irregular grains, some with a very fine stringy texture and others with patches of stringy texture. Perthite contains inclusions of pyroxene and nepheline and is also interstitial to larger pyroxene and nepheline. Nepheline forms subhedral to euhedral crystals, which are generally fresh.

Reference No. 874
Sample No. LW23-3

Pyroxene - biotite nepheline syenite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index approximately 20. Weathered surfaces are pink to grey-pink, fresh surfaces mottled pink and black. Map-unit 5c.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Pyroxene is anhedral, partially engulfs nepheline, and contains poikilitic biotite. Nepheline is anhedral to euhedral and generally fresh. Perthite forms anhedral to subhedral grains. One large perthite grain has a perthitic core and an orthoclase rim, separated by a narrow diffuse zone of alteration. Nepheline is poikilitic in potassium feldspar.

Reference No. 875
Sample No. LW23-4

Melanocratic, biotite - pyroxene nepheline syenite.

Field Description. Medium to coarse grained, massive, equigranular. Rock is homogeneous and has a colour index of approximately 40. Weathered surfaces are dark grey, fresh surfaces mottled pink and black. Map-unit 5c.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Biotite forms anhedral grains associated with pyroxene. Biotite encloses pyroxene and has a bent (001) cleavage. Magnetite is disseminated and anhedral. Pyroxene is an aegirine-augite, forming anhedral to subhedral crystal with pale green cores. Pyroxene encloses biotite and nepheline. Orthoclase is anhedral and interstitial to pyroxene. Nepheline forms anhedral to euhedral crystals partially enclosed within orthoclase.

Reference No. 876
Sample No. LW23-5

Porphyritic, pyroxene nepheline syenite or malignite.

Field Description. Fine to massive grained, massive, inequigranular-porphyritic-seriate. Feldspar phenocrysts up to 5 mm have a seriate distribution. Mafic minerals are somewhat clotted,

and some clots may be xenoliths. Clots were removed from the sample before analysis. Clots are up to 4 mm in maximum dimension. Locally the outcrop is weakly foliated. Isolated feldspar crystals are 2 to 3 cm in size. Map-unit 4c.

Petrographic Description. Fine to medium grained, massive, inequigranular-porphyritic-seriate, hypidiomorphic. Pyroxene is subhedral aegirine-augite. Nepheline forms subhedral to euhedral crystals with seriate distribution. Distinct adcumulus overgrowths on some of the larger grains are commonly defined by rings of inclusions of aegirine-augite and apatite. Perthite is a string type, interlocking with nepheline. Perthite is anhedral in form. Minor accessory anhedral magnetite is present.

Reference No. 877
Sample No. LW23-6

Pyroxene nepheline syenite.

Field Description. Fine to medium grained, massive, inequigranular-porphyritic-seriate. Feldspar phenocrysts up to 5 mm long, in seriate distribution, form 5 to 10 percent of the rock. The outcrop contains scattered ijolitic xenoliths. Locally the outcrop is weakly foliated. Map-unit 4c.

Petrographic Description. In thin section the rock is fine to medium grained, massive, equigranular, hypidiomorphic. Pyroxene is anhedral to subhedral aegirine-augite, with rounded inclusions of nepheline; larger grains have weakly defined, pale green cores. Perthite forms Carlsbad-twinned anhedral to subhedral grains with stringy perthite texture. Nepheline is anhedral and interstitial, with numerous rounded inclusions of aegirine-augite and apatite. Inclusions are located in centre of feldspar and nepheline grains and may be concentrated into rings.

Reference No. 879
Sample No. LW23-7

Pyroxene nepheline syenite.

Field Description. Fine grained, inequigranular-porphyritic-seriate. An occasional feldspar phenocryst appears in outcrop but not in the sample collected. The outcrop is cut by coarse-grained syenite. Local weak foliation and some ijolitic xenoliths are present. Weathered surfaces are grey and fresh surfaces grey to pinkish grey. The surface of a sawn slab has a trachytoidal appearance due to subparallel orientation of platy feldspars. Map-unit 4c.

Petrographic Description. Fine grained, massive, inequigranular-seriate, hypidiomorphic. Pyroxene is a green, anhedral aegirine-augite. Magnetite is anhedral and disseminated. Nepheline is anhedral, interstitial, and weakly altered to sericite (?). Perthite occurs in part as large anhedral grains heavily impregnated with poikilitic inclusions of subangular aegirine-augite and magnetite. Stringy perthite texture is well developed. Rims are generally inclusion-free or very lightly dusted with very fine grained inclusions. Perthite in the groundmass is anhedral, interlocking, and appears granoblastic. Grain boundaries have stitched pattern of quilt. The grain-boundary pattern is likely caused by the incipient breakdown of orthoclase feldspar along grain boundaries into perthite. Spotty vestiges of albite twinning are present in some of the larger perthite grains.

Reference No. 880
Sample No. LW23-9

Biotite - pyroxene nepheline syenite.

Field Description. Medium to coarse grained, massive, inequigranular-seriate. Colour index is approximately 40. Weathered surfaces are dark grey, fresh surfaces mottled pink and black. Map-unit 4c.

Petrographic Description. In thin section the rock is fine to medium grained, massive, equigranular, hypidiomorphic. Biotite forms anhedral, ragged, reddish-brown grains with poikilitic inclusions of pyroxene. Pyroxene is anhedral to euhedral, and contains poikilitic apatite and biotite. Larger augite grains have pale green cores. Orthoclase forms anhedral to subhedral crystals with Carlsbad twinning. Nepheline is subhedral to euhedral, relatively fresh, and partially enclosed in orthoclase.

Reference No. 881
Sample No. LW23-10

Melanocratic, biotite - pyroxene nepheline syenite or malignite.

Field Description. Medium to coarse grained, massive, inequigranular-seriate. Colour index approximately 40. Weathered surfaces are dark grey, fresh surfaces mottled pink and black. The texture approaches porphyritic. Map-unit 6b.

Petrographic Description. In thin section the rock is fine to medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Traces of pyrochlore are

interstitial to pyroxene. Pyroxene is anhedral, irregular aegirine-augite. Larger crystals have pale green cores and are zoned. Aegirine-augite contains some poikilitic apatite and biotite. Biotite forms brown grains, anhedral in outline. Nepheline forms anhedral, irregular grains with rounded poikilitic inclusions of aegirine-augite. Perthite forms anhedral, irregular grains with stringy texture.

Reference No. 882
Sample No. LR23-10

Pyroxene - amphibole nepheline syenite.

Field Description. Coarse grained, massive, equigranular. The rock is probably a dike cutting ijolitic rocks. The outcrop occurs near the contact of ijolite with fine to medium grained nepheline syenite. Colour index 15 to 20. Map-unit 5c.

Petrographic Description. Medium to coarse grained, massive, equigranular, hypidiomorphic. Pyroxene forms anhedral grains of aegirine-augite, some undergoing patchy amphibole replacement. Amphibole is pleochroic in green to brownish green, in part replacing pyroxene. Amphibole also occurs as anhedral, polycrystalline aggregates in association with biotite and possibly traces of garnet. Nepheline forms anhedral to subhedral crystals, which are relatively fresh. Perthite has a weakly stringy texture, and is anhedral in outline; several rounded blebs of nepheline are enclosed.

Reference No. 883
Sample No. LR23-11

Pyroxene nepheline syenite.

Field Description. Fine to medium grained, massive, inequigranular-porphyritic-seriate. Feldspar phenocrysts make up 15 to 20 percent of rock; they are up to 5 mm in maximum dimension. On slabbed surface, the rock appears weakly trachytoidal. Some elliptical clots of biotite are seen in outcrop. Weathered and fresh surfaces are greyish-pink. Map-unit 4c.

Petrographic Description. Fine to medium grained, massive, inequigranular-porphyritic-seriate, hypidiomorphic. Pyroxene is anhedral, green aegirine-augite. Perthite phenocrysts are subhedral to euhedral and Carlsbad-twinned; staining suggests compositional change across concentric zone of inclusions of aegirine-augite and apatite. Perthite of groundmass is anhedral, and interlocking with perthite and nepheline. Nepheline forms anhedral to subhedral grains, which are fresh and contain narrow concentric zones of pyroxene and apatite inclusions.

Reference No. 884
Sample No. LR23-12

Pyroxene - nepheline syenite.

Field Description. Fine to medium grained, inequigranular-porphyritic-seriate. Feldspar phenocrysts up to 5 mm long compose 15 to 20 percent of the rock. Subangular ijolite xenoliths up to 3 cm across compose 1 to 2 percent of rock. Weathered surfaces are greenish-pink, fresh surfaces pinkish-grey. Xenoliths were removed from the sample before analysis. Map-unit 5a.

Petrographic Description. Fine grained, massive, inequigranular-seriate, allotriomorphic, with curved to straight grain boundaries. Aegirine-augite forms anhedral grains with poikilitic inclusions of apatite and nepheline; it has pale green cores. Perthite forms anhedral grains with well developed stringy texture. Nepheline forms anhedral, irregular grains interlocking with perthite. Nepheline and pyroxene contain circular to elliptical zones of inclusions composed of scattered rounded grains of aegirine-augite and apatite.

Reference No. 885
Sample No. LR23-13

Biotite - garnet ijolite.

Field Description. Fine grained, equigranular, massive to weakly gneissic. A weak gneissosity due to variation in mafic to felsic mineral ratios is enhanced by weathering which gives the outcrop a ribbed surface. Rock is magnetic. Weathered and fresh surfaces are black. Map-unit 4a.

Petrographic Description. Fine grained, equigranular, massive, hypidiomorphic. Pyroxene is an aegirine-augite forming anhedral grains interlocking with garnet and nepheline. Nepheline is anhedral, fresh, and interlocking with pyroxene and garnet. Garnet is anhedral to subhedral and interlocks with nepheline and pyroxene. Garnet is dark brown. Biotite forms anhedral to subhedral grains in association with garnet and pyroxene. Minor apatite forms euhedral crystals. Minor disseminated, anhedral magnetite is present. Grain boundary relations display a granoblastic texture.

Reference No. 886
Sample No. LR23-14

Perthite- and biotite-bearing ijolite.

Field Description. Fine grained, equigranular. Outcrop has some 1 to 3 mm elongated clots of biotite. Rock is magnetic. Weathered surfaces are grey-black, fresh surfaces black. Map-unit 4c.

Petrographic Description. Fine to medium grained, inequigranular-porphyritic-seriate, allotriomorphic with curved grain boundaries. Rock is granoblastic in appearance. Aegirine-augite phenocrysts are subhedral with ragged edges. Rims of grains contain abundant poikilitic biotite. Grains are altered but were originally zoned and twinned. Aegirine-augite in groundmass is anhedral and fresh. Disseminated magnetite is present. Anhedral carbonate occurs interstitially. Brown anhedral biotite interlocks with pyroxene. Nepheline is anhedral, fresh, and interlocking. Perthite and orthoclase form anhedral grains interlocking with pyroxene and nepheline. Perthite texture is stringy and very fine grained where present.

Reference No. 887
Sample No. LR23-15

Pyroxene nepheline syenite.

Field Description. Fine to medium grained, inequigranular-porphyritic-seriate. Feldspar phenocrysts up to 5 mm long make up approximately 10 percent of the rock. Rock is weakly gneissic due to mafic streaking and locally ijolitic xenoliths form 10 to 15 volume percent of the rock. Weathered surfaces are pinkish grey, fresh surfaces greyish-pink. Xenoliths were removed from the sample before analysis. Map-unit 4c.

Petrographic Description. Fine to medium grained, equigranular, massive, hypidiomorphic. Pyroxene forms anhedral, irregular grains interstitial to feldspar and nepheline. Pyroxene is aegirine-augite. Nepheline is anhedral to subhedral and interlocking with feldspar; spotty alteration occurs along cleavage planes. Potassium feldspar is anhedral to subhedral perthite of stringy type. Nepheline and feldspar contains rings and partial rings, commonly centrally distributed, of tiny poikilitic inclusions of pyroxene and apatite.

Reference No. 888
Sample No. LR23-16

Pyroxene nepheline syenite.

Field Description. Medium grained, inequigranular-porphyritic-seriate. Potassium feldspar phenocrysts up to 6 mm across, in seriate distribution, comprise 5 to 10 percent of the rock. Several ijolitic xenoliths are present in outcrop. Weathered and fresh surfaces are pink. Map-unit 5a.

Petrographic Description. Fine grained, massive, inequigranular-seriate, hypidiomorphic. Pyroxene is anhedral, irregular aegirine-augite. Nepheline forms anhedral to subhedral grains with incipient alteration along cleavages. Nepheline contains an occasional inclusion of aegirine-augite and apatite. Perthite forms anhedral grains with stringy perthite texture. Perthite contains ring-like inclusion zones of rounded aegirine-augite and apatite. Colour tinting on extinction suggest compositional variation across inclusion zone.

Reference No. 889
Sample No. LR23-17

Nepheline syenite.

Field Description. Medium grained, equigranular. Several biotite clots occur in the outcrop. Clots are up to 1.5 cm in diameter, and are possible altered xenoliths. Weathered and fresh surfaces are pink. Map-unit 5a.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Nepheline is anhedral to subhedral and interlocked with feldspar and pyroxene. Pyroxene is anhedral, interstitial, irregular aegirine-augite. Perthite is Carlsbad-twinned string perthite. Biotite forms reddish-brown anhedral grains with poikilitic inclusions of apatite and anhedral pyroxene. Nepheline and feldspar contain rings and partial rings of tiny inclusions of pyroxene and apatite.

Reference No. 890
Sample No. LR23-18

Biotite - pyroxene nepheline syenite.

Field Description. Medium grained, equigranular. Elliptical biotite clots are up to 4 cm in long dimension with one clot is 20 cm long. Larger clot has a bleached rim 2 cm in width. Weathered surfaces are greyish-pink and fresh surfaces pink. Map-unit 5b.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Biotite forms reddish-brown, anhedral, irregular interstitial grains. Nepheline is anhedral to subhedral and generally fresh. Perthite is Carlsbad-twinned, very fine stringy perthite. Aegirine-augite is anhedral and interstitial to nepheline and feldspar. Disseminated magnetite in places has biotite along rims. Biotite is poikilitic in pyroxene. Feldspar and nepheline contain small inclusions which locally form partial rings.

Reference No. 891
Sample No. LR23-19

Pyroxene nepheline syenite.

Field Description. Medium to coarse grained, equigranular. Locally, mafic minerals are clotty to streaky. Weathered and fresh surfaces are pink. Map-unit 5a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Nepheline is anhedral to euhedral and fresh. Nepheline contains an occasional anhedral grain of pyroxene. Perthite forms anhedral, irregular grains, some with Carlsbad twinning. Stringy perthite texture is well developed. Aegirine-augite forms anhedral, irregular grains.

Reference No. 892
Sample No. LR23-20

Ijolite.

Field Description. Coarse grained, massive, equigranular, homogeneous. Colour index 30 to 40. Weathered surfaces are grey, fresh surfaces mottled pink and black. Map-unit 5b.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Orthoclase forms clear grains interlocking with nepheline and pyroxene. Orthoclase is minor. Minor brown biotite forms large irregular grains with rounded poikilitic grains of nepheline and pyroxene. Pyroxene is anhedral to euhedral aegirine-augite, which is weakly zoned and occasionally contains a small poikilitic biotite inclusion. Nepheline is subhedral to euhedral with spotty alteration along cleavages.

Reference No. 893
Sample No. LR23-23

Pyroxene nepheline syenite.

Field Description. Coarse grained, massive, equigranular. Colour index is 35 to 40. Weathered surfaces are mottled grey pink and black, fresh surfaces pink and black. Map-unit 4c.

Petrographic Description. Medium grained, equigranular, massive, hypidiomorphic to allotriomorphic, with curved to straight grain boundaries. Biotite forms brown anhedral crystals, often with minor kinking. Pyroxene is a pale green aegirine-augite, anhedral to subhedral in form; locally, it contains poikilitic biotite and traces of apatite. Perthite forms anhedral, irregular grains with stringy texture; it interlocks with nepheline. Nepheline is fresh, forms anhedral to subhedral grains, and interlocks with perthite.

Reference No. 894
Sample No. LW30-2

Biotite - pyroxene nepheline syenite.

Field Description. Coarse grained, massive, equigranular. Colour index approximately 10. Weathered surfaces are buff, fresh surfaces pinkish with black spots. Map-unit 5c.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Brown anhedral biotite interlocks with and is associated with pyroxene. Some pyroxene is enclosed within biotite. Pyroxene is anhedral, somewhat rounded in form, and interlocking with biotite. Nepheline forms anhedral to euhedral crystals, generally fresh in appearance; some nepheline is poikilitic in feldspar. Perthite forms anhedral grains, which are Carlsbad-twinned, and have well developed stringy texture.

Reference No. 895
Sample No. LW30-3

Biotite - pyroxene nepheline syenite.

Field Description. Coarse grained, massive, equigranular, homogeneous. Colour index approximately 10. Weathered surfaces are buff, fresh surfaces pink with black spots (mafics). Map-unit 5c.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Apatite is euhedral to subhedral and poikilitic in pyroxene and biotite. Pyroxene is anhedral to subhedral

aegirine-augite. Biotite is anhedral, brown in colour, and interlocking with pyroxene. Nepheline forms anhedral to euhedral crystals generally fresh in appearance. Nepheline, in part, interlocks with feldspar. Perthite forms anhedral grains, with some Carlsbad twinning and well developed stringy texture.

Reference No. 896
Sample No. LW30-4

Biotite nepheline syenite.

Field Description. Coarse grained, massive, equigranular. The outcrop is cut by magnetite veins. Weathered and fresh surfaces are pink. Colour index 5 to 10. Map-unit 5c.

Petrographic Description. Coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Pyroxene is anhedral aegirine-augite but only one or two grains are present. Biotite is anhedral, interlocking, and intergranular to feldspar. Nepheline forms anhedral to subhedral grains, which are fresh in appearance. Minor cancrinite occurs along edges of nepheline grains. Perthite forms Carlsbad-twinned crystals, anhedral in form, with stringy perthite texture.

Reference No. 897
Sample No. LW30-5

Porphyritic, pyroxene nepheline syenite.

Field Description. Medium grained, inequigranular-seriate. Outcrop appears brecciated from veining. Magnetite blebs and stringers are present in outcrop. Sample was taken from homogeneous portion of outcrop mapped as ijolite. Weathered surfaces are dark grey, fresh surfaces black. Map-unit 3a.

Petrographic Description. Fine to medium grained, massive, inequigranular, porphyritic-seriate, hypidiomorphic. Pyroxene of aegirine-augite composition forms subhedral to anhedral grains. Nepheline forms subhedral to euhedral phenocrysts, which contain a ring of tiny aegirine and apatite (?) inclusions outlining crystal form. Nepheline has had overgrowth. Nepheline of groundmass is anhedral, contains poikilitic inclusions and interlocks with perthite. Perthite is anhedral and stringy; perthite grains interlock with nepheline.

Reference No. 898
Sample No. LW30-6

Biotite nepheline syenite.

Field Description. Coarse grained, massive, equigranular, leucocratic. Colour index about 10. Weathered and fresh surfaces are pink to buff. Map-unit 5c.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Albite (An4-8) forms a few scattered small grains intergranular to perthite. Biotite forms brown anhedral grains interstitial to feldspar. Nepheline forms anhedral to subhedral, fresh to slightly altered grains. Perthite forms anhedral grains with well developed stringy texture.

Reference No. 899
Sample No. LW30-8

Ijolite.

Field Description. Medium grained, equigranular, massive to brecciated. The outcrop is cut by magnetite-apatite veins. Weathered surfaces are grey, fresh surfaces dark grey. Map-unit 3a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene is anhedral, irregular and somewhat rounded in form. Larger grains have pale green cores. Nepheline forms anhedral to subhedral grains, partially enclosed by pyroxene. Rock texture is homogeneous, and there is no evidence of brecciation in thin section.

Reference No. 901
Sample No. LW30-9

Carbonate- and biotite-bearing ijolite.

Field Description. Fine to medium grained, massive, inequigranular-seriate. Rock appears homogeneous on outcrop surface, however slabbed surface displays irregular buff-coloured patches of irregular shape and gradational boundaries. Buff or light coloured areas may be feldspathic segregations. Weathered surfaces are grey, fresh surfaces dark grey to grey-black. Map-unit 3a.

Petrographic Description. Fine to medium grained, equigranular, massive, hypidiomorphic. Biotite is minor and forms anhedral brown grains intergranular to pyroxene. One grain of biotite

contains poikilitic carbonate and nepheline. Pyroxene is anhedral to euhedral in outline. Euhedral pyroxene project into carbonate. Larger pyroxene grains have pale green cores and are zoned. One or two small biotite grains are poikilitic in pyroxene. Nepheline is anhedral to euhedral. Euhedral nepheline grains project into carbonate.

Reference No. 902
Sample No. LW30-10A

Pyroxene - biotite nepheline syenite.

Field Description. Coarse grained, massive to weakly trachytoidal, equigranular, homogeneous. Weathered surfaces are buff, fresh surfaces mottled pink and buff. Colour index 10 to 15. Map-unit 5c.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Plagioclase (An6-8) forms anhedral to subhedral crystals undergoing patchy replacements by potassium feldspar. Perthite is anhedral, interstitial, and has well developed stringy texture. Nepheline forms subhedral to euhedral, clear grains with minor alteration along cleavages and rarely cancrinite alteration along rims. Biotite forms reddish-brown, anhedral grains enclosing pyroxene. Pyroxene is a green aegirine-augite closely associated with biotite.

Reference No. 903
Sample No. LW30-10B

Ijolite.

Field Description. Fine grained, massive, equigranular. Rock is homogeneous. Weathered and fresh surfaces are dark grey-black. Map-unit 3a.

Petrographic Description. Fine grained, massive, inequigranular-seriate, allotriomorphic, with curved grain boundaries. Mafic minerals tend to form clots and to be coarser grained. Pyroxene is a green aegirine-augite, anhedral with irregular outline. Pyroxene partially encloses some nepheline grains. Nepheline forms anhedral, fresh to moderately fresh grains interlocking with pyroxene. Nepheline contains numerous small poikilitic inclusions of aegirine-augite. Potassium stain is well developed along altered cleavage planes in nepheline.

Reference No. 904
Sample No. LW30-12

Ijolite.

Field Description. Fine grained, equigranular, massive. On cut surface colour is mottled from dark pinkish-grey to grey-black, implying some inhomogenity. Weathered surfaces are grey, fresh surfaces dark grey. Map-unit 3a.

Petrographic Description. Fine grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Pyroxene is anhedral, irregular, rounded, aegirine-augite. Nepheline forms fresh, anhedral to subhedral grains interlocking with pyroxene.

Reference No. 905
Sample No. LW30-13

Ijolite.

Field Description. Fine grained, massive to brecciated, equigranular. The sample selected for analysis was homogeneous. Outcrop is cut by magnetite veins. Blebs and anhedral crystals of magnetite are locally present. Weathered surfaces are grey to black, fresh surfaces dark grey. Map-unit 3a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene is aegirine-augite, which is anhedral and irregular in form. Nepheline is fresh and anhedral in outline. Small blebs of nepheline are enclosed in pyroxene. Mineralogy slightly clotty. Texture appears almost granoblastic.

Reference No. 906
Sample No. LW30-14

Ijolite.

Field Description. Fine grained, massive to brecciated, equigranular on weathered outcrop surface. A pegmatite vein along one side of rock on slabbed surface indicates a coarsening of texture to medium grained, and some of the rock may be pegmatitic in nature. The vein was removed from the sample before analysis. Weathered and fresh surfaces are black to grey-black. Map-unit 3a.

Petrographic Description. Fine grained, massive, inequigranular-seriate, allotriomorphic, with curved grain boundaries. Pyroxene is anhedral, rounded, irregular aegirine-augite. Nepheline is

anhedral, irregular, and interlocking with pyroxene. A brecciated appearance is due to grain size variation and variation in pyroxene–nepheline ratios. Mineralogy is similar throughout.

Reference No. 907
Sample No. LW30-16

Ijolite.

Field Description. Fine to medium grained, equigranular, massive. Local areas of outcrop have nepheline, feldspar, and biotite. Weathered surfaces are grey, fresh surfaces black. Map-unit 4a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene is anhedral, irregular aegirine-augite. Apatite is poikilitic in pyroxene. Nepheline is anhedral, irregular, and interlocks with pyroxene.

Reference No. 908
Sample No. LW30-17

Melanocratic, pyroxene nepheline syenite or malignite.

Field Description. Fine to medium grained, massive to weakly schistose, inequigranular–seriate on weathered outcrop. Local area of coarsening grain size implies some pegmatitic development. Local isolated nepheline crystals are up to 0.3 cm across. Outcrop is cut by feldspar – nepheline – biotite dikes. Contacts are sharp and the dike may contain mafic xencliths with feldspar-rich rims. Biotite grains in dikes are up to 2 cm in diameter. Area sampled is homogeneous in appearance. Map-unit 4b.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene forms anhedral, irregular grains interlocking with nepheline. Pyroxene is aegirine-augite. Nepheline forms anhedral to subhedral, fresh grains. Feldspar is perthite with a very fine perthitic texture, in part visible only at highest magnification. Larger nepheline and feldspar grains contain a circular zone of rounded inclusions of pyroxene and apatite. Two periods of growth are apparent.

Reference No. 909
Sample No. LW30-18A

Biotite-bearing ijolite.

Field Description. Fine to medium grained, inequigranular–seriate, massive. Outcrop is cut by numerous, feldspar–biotite syenite dikes. Outcrop locally has a weak foliation. Weathered surfaces are blue-grey, fresh surfaces dark grey. Map-unit 4a.

Petrographic Description. Fine grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Thin section displays dike-like zones of finer grained ijolite with identical mineralogy and texture. Biotite forms brown subhedral grains. Pyroxene is aegirine-augite. Pyroxene forms anhedral, irregular grains interlocking with nepheline. Nepheline is anhedral to subhedral, interlocking with pyroxene. Alteration along cleavage gives a good stain for potassium. Nepheline contains small poikilitic inclusions of pyroxene.

Reference No. 910
Sample No. LW30-18B

Biotite – pyroxene nepheline syenite.

Field Description. Medium grained, equigranular, massive. Colour index is 25 to 35. Weathered surfaces are buff, fresh surfaces are mottled pale pink and black. Map-unit 5b.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Biotite forms anhedral, brown, interlocking grains in association with pyroxene. Pyroxene forms anhedral to subhedral grains, which show traces of spotty alteration to amphibole; some pyroxene is mantled by dark green amphibole. Nepheline is anhedral to subhedral in form, interlocking with pyroxene and feldspar. Perthite forms an interlocking mosaic of anhedral grains and is interlocked with nepheline and pyroxene. Stringy perthite texture is well developed.

Reference No. 911
Sample No. LW30-20A

Biotite – pyroxene – amphibole nepheline syenite.

Field Description. Medium to coarse grained, massive, equigranular. Colour index 30 to 35. Weathered surfaces are buff, fresh surfaces mottled black and pinkish buff. Map-unit 5a.

Petrographic Description. Medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Biotite grains are anhedral and irregular; commonly biotite mantles magnetite

and interlocks with amphibole and pyroxene. Apatite is anhedral to subhedral in outline. Amphibole is anhedral, pleochroic green to brownish green. Nepheline is anhedral and interlocking with feldspar. Tiny needle-like poikilitic apatite grains are contained in nepheline. Perthite is a stringy type, with rounded nepheline inclusions and some Carlsbad twinning.

Reference No. 912
Sample No. LW30-20B

Amphibole - biotite nepheline syenite.

Field Description. Fine to medium grained, equigranular, homogeneous, trachytoidal due to platy feldspars. Weathered surfaces are grey, fresh surfaces grey-pink. Map-unit 5b.

Petrographic Description. Fine grained, massive, equigranular, hypidiomorphic. Cancrinite occurs interstitially. Nepheline forms anhedral to subhedral crystals, fresh in appearance. Perthite forms anhedral grains with well developed stringy texture, some with Carlsbad twinning. Biotite forms anhedral, brown ragged grains, intergranular to feldspar. Amphibole is a pleochroic, deep greenish-brown, sodium-iron variety.

Reference No. 913
Sample No. LW30-21

Biotite - amphibole nepheline syenite.

Field Description. Medium to coarse grained, massive, equigranular, homogeneous. Colour index 25 to 30. Weathered surfaces are greenish pink, fresh surfaces mottled pink and black. Map-unit 5b.

Petrographic Description. Medium grained, massive, equigranular, hypidiomorphic. Amphibole forms pleochroic, brown, anhedral grains of a sodium-iron variety. Trace to minor relict pyroxene is present. Biotite forms brown, anhedral, irregular grains. Apatite is poikilitic in amphibole. Apatite is subhedral to anhedral in form. Nepheline is subhedral to anhedral, and fresh in appearance. Perthite is subhedral to anhedral, has a well developed stringy texture, and is interlocking with nepheline.

Reference No. 914
Sample No. LW30-22

Pyroxene nepheline syenite.

Field Description. Very fine to medium grained, inequigranular-porphyritic-seriate. Elongate to tabular feldspar phenocrysts are up to 8 mm long. Weathered and fresh surfaces are greyish pink. Rock is homogeneous, except for a weak suggestion of trachytoidal texture in feldspars on sawn surface. Map-unit 5a.

Petrographic Description. Fine grained, massive, equigranular to inequigranular-porphyritic-seriate, allotriomorphic, with curved to straight grain boundaries. Pyroxene forms anhedral, irregular grains of aegirine-augite. Nepheline forms anhedral to subhedral grains, fresh in appearance. Perthite forms anhedral, irregular grains with well developed stringy texture. Perthite forms an interlocking mosaic with nepheline. Circular zones of rounded inclusions occur in larger grains of nepheline and perthite. Variation in extinction across inclusion zone suggests two periods of growth or possible composition variations.

Reference No. 915
Sample No. LW30-23

Pyroxene - garnet ijolite (urtite).

Field Description. Very fine grained, slightly inequigranular-porphyritic-seriate. Feldspar phenocrysts reach a maximum of 1 cm in length. Weathered and fresh surfaces are grey. Map-unit 4c.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Magnetite occurs in disseminated anhedral grains. Garnet forms yellow-brown, anhedral grains interlocking with aegirine-augite. Aegirine-augite forms a mosaic of anhedral to subhedral crystals. Good stain for potassium along cleavage planes. Very minor biotite occurs as an aggregate of grains. Nepheline forms an interlocking mosaic of anhedral to subhedral grains. Nepheline composes 70% or more of the rock.

Reference No. 916
Sample No. LW30-25

Biotite - pyroxene nepheline syenite.

Field Description. Medium to coarse grained, massive, equigranular, homogeneous. Colour index 25 to 30. Weathered and fresh surfaces are mottled pink and greenish black. Map-unit 5c.

Petrographic Description. Fine to medium grained, massive, equigranular, hypidiomorphic. Pyroxene is aegirine-augite and forms anhedral, irregular grains, some with patchy alteration to amphiboles. Pyroxene contains poikilitic apatite. Minor biotite is intergranular to pyroxene. Nepheline forms subhedral to anhedral crystals interlocking with perthite. Perthite is stringy type, Carlsbad-twinned, and interlocking with pyroxene and nepheline.

Reference No. 917
Sample No. LW30-28

Ijolite.

Field Description. Fine grained, massive to banded, equigranular, homogeneous. Coarse grained mafic plus feldspar segregations impart a banding to the outcrop. Weathered surfaces are grey, fresh surfaces dark grey. Map-unit 3a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene is an aegirine-augite, and is anhedral, irregular, and interlocking with nepheline. Nepheline is fresh, anhedral in outline and interlocks with pyroxene. The rock is mineralogically homogeneous. Banding in outcrop is due to variations in mineral proportions and grain size across the outcrop surface.

Reference No. 918
Sample No. LW30-30

Biotite-bearing ijolite.

Field Description. Very fine grained, equigranular. Rare biotite plates are up to 1.5 cm in diameter. In hand sample, the rock looks homogeneous but on cut surface it has a brecciated appearance. Individual clasts are separated by thin (less than 2 mm wide) fractures filled with carbonate and biotite. Breccia matrix is very minor and may be a segregation from the ijolite since contacts are diffuse and breccia development is indistinct in portions of the sample. Weathered and fresh surfaces are grey-black. Map-unit 3a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene forms anhedral, irregular grains of aegirine-augite. Nepheline forms anhedral to subhedral grains, which are fresh, and show potassium stains along fractures. Biotite forms anhedral grains with poikilitic pyroxene and nepheline.

Reference No. 919
Sample No. LW30-33

Biotite-bearing ijolite.

Field Description. Fine grained, massive, equigranular, homogeneous. Weathered surfaces are grey, fresh surfaces dark grey. Map-unit 3a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene is an anhedral, irregular aegirine-augite interlocking with nepheline. Nepheline is anhedral to subhedral in outline with some poikilitic pyroxene. Minor biotite is anhedral and intergranular to pyroxene.

Reference No. 920
Sample No. LW30-34

Magnetite ijolite.

Field Description. Fine grained, equigranular, massive. The outcrop is cut by a magnetite vein 2 to 4 cm wide. Weathered and fresh surfaces are dark grey to dark grey black. Map-unit 3a.

Petrographic Description. Fine grained, massive, inequigranular-seriate, allotriomorphic, with curved grain boundaries. Nepheline forms anhedral to subhedral grains interlocking with other nephelines and pyroxene. Nepheline is generally fresh, and contains traces of fine grained poikilitic apatite and pyroxene. Pyroxene forms anhedral, irregular grains with pale green cores. These cores reflect possible compositional zoning of the pyroxene grains. Magnetite forms irregular elongated clots, in part, defining a weak foliation.

Reference No. 921
Sample No. LW30-36

Ijolite.

Field Description. Fine to medium grained, inequigranular-seriate. The outcrop is cut by coarse magnetite and nepheline syenite veins. On sawn surface the rock appears inhomogeneous with pink, more leucocratic areas grading into darker, finer grained areas. Weathered and fresh surfaces are mottled pink and greenish grey. Map-unit 3a.

Petrographic Description. Fine to medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Nepheline is anhedral to subhedral in form, interlocking with

other nepheline and pyroxene grains. Pyroxene is a green aegirine-augite, anhedral to irregular in outline. Larger pyroxene grains are weakly zoned, with paler green cores.

Reference No. 922
Sample No. BC13-1C

Ijolite.

Field Description. Fine grained, massive, equigranular. Weathered and fresh surfaces are black. The outcrop is extensively diked with fine grained pink nepheline syenite stringers and veins. Sample for analysis was homogeneous. Map-unit 3a.

Petrographic Description. Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Pyroxene is anhedral, irregular, green aegirine-augite, interlocking with nepheline. Nepheline is anhedral to subhedral and interlocking with pyroxene.

Reference No. 923
Sample No. BC13-5B

Pseudoleucite - pyroxene nepheline syenite.

Field Description. Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic. Circular to elliptical leucocratic clots are up to 2 cm in diameter. Clots consist of nepheline and potassium feldspar, possibly former pseudoleucite. Cores of some clots contain a mafic mineral. Weathered and fresh surfaces are mottled pink and buff. Sample was taken from outcrop along or close to contact of No. 6 ore zone with nepheline syenite. Not a mappable unit.

Petrographic Description. Fine to medium grained, massive, inequigranular-seriate, hypidiomorphic. Circular zones of interlocking nepheline and potassium feldspar are possibly pseudoleucite. Larger circular zones have aegirine-augite - biotite cores. Circular zones are enclosed in a fine grained groundmass which contains the occasional, large, Carlsbad-twinned orthoclase grain. These large crystals give a porphyritic texture to the groundmass and contain poikilitic pyroxene along rims. Pyroxene is an aegirine-augite. Nepheline forms anhedral to subhedral grains interlocking with potassium feldspar. Orthoclase forms anhedral, irregular grains interlocking with nepheline in the circular nepheline - potassium feldspar areas, and in the finer grained groundmass. Orthoclase also forms large anhedral to subhedral, Carlsbad-twinned crystals in groundmass. The circular zones may be the result of breakdown of pseudoleucite.

Reference No. 924
Sample No. LAC-1

Pyroxene - apatite - magnetite sovite.

Fine to coarse grained, massive, inequigranular-seriate, hypidiomorphic. Magnetite forms anhedral disseminated grains which in part are skeletal. Pyroxene forms anhedral to subhedral grains of aegirine-augite composition, which contain poikilitic inclusions of apatite and magnetite. Apatite forms anhedral rounded bead-like grains, commonly elongate in outline. Anhedral grains of carbonate form an interlocking mosaic. Map-unit 6.

Reference No. 925
Sample No. LAC-2

Pyroxene - apatite - magnetite sovite.

Fine to coarse grained, massive, inequigranular-seriate, hypidiomorphic. Apatite forms rounded bead-like grains which are commonly elongate. Pyroxene forms euhedral to anhedral green crystals, commonly containing poikilitic apatite and traces of pyrochlore. Magnetite forms irregular ragged grains which are in part skeletal; magnetite is disseminated throughout. Pyrochlore occurs as brown very small grains, poikilitic in pyroxene. Carbonate forms an interlocking mosaic of anhedral grains. Map-unit 6.

Reference No. 926
Sample No. LAC-3

Pyroxene - apatite sovite.

Fine to coarse grained, massive, inequigranular-seriate, hypidiomorphic. Pyroxene forms euhedral to subhedral grains with embayed grain boundaries. Some grains contain poikilitic apatite. Apatite forms bead-like grains sometimes elongated in outline. Carbonate forms an interlocking mosaic of anhedral grains. Map-unit 6.

Reference No. 927
Sample No. LAC-4

Pyroxene - apatite - magnetite sovite.

Fine to coarse grained, massive, inequigranular-seriate, hypidiomorphic. Pyroxene is turbid and is partly altered to carbonate. Pyroxene contains poikilitic apatite. Magnetite forms skeletal

crystals, which sometimes form a complete ring enclosing carbonate. Apatite occurs as rounded bead-like grains, commonly elongate. Pyrochlore forms euhedral to subhedral grains, some with dark brown rims and pale brown cores. Carbonate forms an interlocking mosaic of anhedral grains. Map-unit 6.

Reference No. 928
Sample No. LAC-5

Magnetite - apatite - pyroxene sovite.

Fine to coarse grained, massive, inequigranular-seriate, hypidiomorphic. Apatite forms rounded, elongate, bead-like grains. Magnetite forms irregular, ragged disseminated grains. Pyrochlore forms euhedral brown grains commonly zoned from dark brown rims to pale brown cores. Cores of some grains contain small, very dark, nearly opaque inclusions. Pyroxene is a green aegirine-augite with embayed grain margins. Larger pyroxene grains contain abundant poikilitic apatite. Carbonate forms anhedral interlocking grains. Map-unit 6.

Reference No. 929
Sample No. L1 139.0-139.2

Ijolite.

Fine grained, massive, equigranular, allotriomorphic, granoblastic, with curved grain boundaries. Nepheline is fresh, euhedral and forms an interlocking mosaic with pyroxene. Some very small elongate inclusions of possible apatite are aligned parallel to cleavage of nepheline. Pyroxene is dark green anhedral aegirine-augite which forms an interlocking mosaic with nepheline. Very minor interstitial potassium feldspar occurs as amoeboid, optically continuous grains enclosing nepheline and pyroxene. Map-unit 4a.

Reference No. 930
Sample No. L1 168.1 - 168.85

Aegirine-augite nepheline syenite.

Medium to coarse grained, massive, equigranular, hypidiomorphic. Nepheline forms anhedral to subhedral crystals which have undergone some alteration to cancrinite along their edges. Pyroxene is dark green anhedral aegirine-augite. Orthoclase occurs interstitially to nepheline and pyroxene and may partially enclose euhedral crystals of nepheline. Some Carlsbad twinning is present. Trace amounts of carbonate, magnetite, and apatite are present. Map-unit equivalent 5c.

Reference No. 931
Sample No. L2 79.0 -79.8

Aegirine-augite nepheline syenite.

Medium grained, massive, equigranular, allotriomorphic to hypidiomorphic, with straight to curved grain boundaries. Minor magnetite is associated with pyroxene. Biotite commonly occurs as narrow rims on magnetite. Pyroxene is dark green aegirine-augite forming irregular grains interlocking with nepheline and feldspar. Nepheline forms anhedral to subhedral grains interlocking with pyroxene and feldspar. Potassium feldspar is tabular, Carlsbad-twinned orthoclase. The grains are anhedral to subhedral, interlocking with pyroxene and nepheline. Map-unit 5c.

Reference No. 932
Sample No. L2 117.65

Melanocratic aegirine-augite nepheline syenite or malignite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Nepheline forms anhedral grains interlocking with feldspar and pyroxene. Some grains are extensively altered to cancrinite. Potassium feldspar is orthoclase, forming tabular crystals which are anhedral to subhedral in form. Feldspar may partially enclose pyroxene and nepheline. Pyroxene is anhedral dark green aegirine-augite interlocking with feldspar and nepheline. Texture is slightly granoblastic. Map-unit 4b.

Reference No. 933
Sample No. L2 136.8 - 137.2

Apatite-bearing ijolite.

Fine grained, equigranular, massive, allotriomorphic, granoblastic, with curved grain boundaries. Apatite forms anhedral to subhedral elongate crystals. Pyroxene forms anhedral to subhedral grains of dark green aegirine-augite. Nepheline forms an interlocking mosaic of anhedral grains. Nepheline rarely poikilitically encloses pyroxene. Map-unit 4a.

Reference No. 934
Sample No. L2 150.65 - 151.0

Apatite-bearing ijolite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. The texture could be classified as granoblastic. Nepheline forms anhedral grains interlocking with pyroxene. Nepheline is generally fresh with traces of cancrinite (?) alteration. Pyroxene is anhedral, dark green aegirine-augite interlocking with nepheline. There are a few anhedral, optically continuous, amoeboid grains of potassium feldspar. Map-unit 4a.

Reference No. 935
Sample No. L2 218.6 - 218.8

Magnetite-bearing ijolite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. The texture grades into granoblastic. Anhedral to subhedral grains of nepheline form an interlocking mosaic. Nepheline is fresh. Pyroxene is anhedral, dark green aegirine-augite; it locally encloses subhedral grains of nepheline. Map-unit 4a.

Reference No. 936
Sample No. L2 223.6 - 223.8

Apatite-bearing ijolite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. The texture tends toward granoblastic. Magnetite is subhedral, disseminated and occurs along pyroxene-nepheline contacts. Magnetite encloses pyroxene. Apatite is anhedral to subhedral; small grains are poikilitic in nepheline. Anhedral grains of nepheline form an interlocking mosaic with pyroxene. Nepheline locally contains poikilitic pyroxene. Pyroxene is dark green aegirine-augite, anhedral in form. Larger grains may contain poikilitic subhedral nepheline. Map-unit 4a.

Reference No. 937
Sample No. L2 243.3 - 243.6

Ijolite.

Fine grained, massive, equigranular to inequigranular-porphyritic-seriate, allotriomorphic, with curved grain boundaries. Texture has a tendency towards granoblastic. One or two nepheline phenocrysts are euhedral in form. Magnetite is anhedral, disseminated and occurs between nepheline and pyroxene. Occasional small grains of magnetite occur within the pyroxene. Small pyroxene grains are poikilitic in nepheline. Pyroxene forms anhedral grains interlocking with nepheline. Pyroxene is aegirine-augite. Map-unit 4a.

Reference No. 938
Sample No. L2 271.6 - 272.0

Leucocratic, biotite nepheline syenite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Texture tends towards granoblastic. Nepheline forms anhedral to subhedral grains with moderate to extensive alteration to cancrinite along grain boundaries and margins. Potassium feldspar forms large anhedral grains of optical continuity, and encloses or partially encloses anhedral to euhedral nepheline crystals. Minor anhedral interstitial reddish-brown biotite occasionally encloses small grains of aegirine-augite. Map-unit 5c.

Reference No. 939
Sample No. L5 46.5-46.9

Leucocratic, biotite - pyroxene - nepheline ijolite.

Medium to coarse grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Carbonate is minor and interstitial. Magnetite is anhedral, disseminated and closely associated with pyroxene and biotite. Biotite occurs as tabular brown grains and as ragged grains in association with pyroxene and magnetite. The pyroxene is dark green aegirine-augite, and is closely associated with biotite and magnetite. Nepheline forms anhedral crystals interlocking with feldspar. Traces of cancrinite alteration are present. Perthite is Carlsbad-twinned, stringy, anhedral, and interlocked with nepheline grains. Map-unit 5c.

Reference No. 940
Sample No. L5 91.1 - 91.3

Biotite ijolite.

Fine grained, equigranular, massive, allotriomorphic, granoblastic, with curved to straight grain boundaries. Biotite forms tabular brown to reddish-brown grains interlocking with nepheline

and pyroxene. Biotite tends to form slightly larger grains than the other mineral components. Pyroxene forms anhedral, crudely rounded grains of aegirine-augite, interlocking with nepheline. Nepheline forms anhedral grains interlocking with pyroxene and biotite. Anhedral magnetite is disseminated throughout. Map-unit 4a.

Reference No. 941
Sample No. L5 214.3 - 214.9

Leucocratic, biotite - pyroxene nepheline syenite.

Medium to coarse grained, massive, equigranular, allotriomorphic with straight to curved boundaries. Very small grains of carbonate occur interstially. Pyroxene is anhedral, aegirine-augite which is irregular in form and poikilitic in biotite or associated with biotite. Biotite is reddish-brown and contains poikilitic pyroxene. Perthite forms large anhedral crystals with Carlsbad twinning. Perthite has a faint string texture and local small patches of sodic plagioclase. Occasional, very small sodic plagioclase grains occur between larger feldspar grains. Nepheline forms anhedral grains interlocking with perthite. Minor alteration to cancrinite. Map-unit 5c.

Reference No. 942
Sample No. L6 51.3 -51.7

Biotite - aegirine-augite nepheline syenite.

Medium grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Carbonate occurs as interstitial grains. Nepheline forms fresh anhedral grains interlocking with feldspar. Traces of cancrinite alteration are present. Perthite is stringy and occurs in tabular grains which are Carlsbad-twinned. Perthite grains interlock with nepheline and other feldspar crystals anhedral to subhedral. Biotite is a reddish-brown, anhedral, and closely associated with aegirine-augite. Magnetite poikilitically encloses pyroxene. Aegirine-augite is dark green and anhedral; it rarely encloses nepheline poikilitically, and is closely associated with biotite and minor disseminated magnetite. Map-unit 5c.

Reference No. 943
Sample No. L8 169.2 - 169.75

Biotite - aegirine-augite nepheline syenite.

Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Biotite is anhedral and forms dark reddish-brown grains; it is ragged where associated with pyroxene which it may poikilitically enclose. Biotite is interstitial to feldspars. Aegirine-augite forms anhedral grains, commonly rimmed and being replaced (?) by biotite. Nepheline forms fresh anhedral grains interlocking with feldspar. Perthite forms tabular Carlsbad-twinned grains interlocking with nepheline and other feldspars. Perthite has a stringy texture. Patches and isolated grains of sodic plagioclase (An11) occur along margins of some perthite grains. Map-unit 5c.

Reference No. 944
Sample No. L9 111.3 - 111.65

Apatite-bearing ijolite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Texture tends toward granoblastic. Apatite forms anhedral, slightly elongated grains interlocking with nepheline and pyroxene. Nepheline forms anhedral fresh grains interlocking with pyroxene; some grains approach being subhedral. Aegirine-augite is dark green, anhedral, and occasionally contains poikilitic nepheline. Map-unit 4a.

Reference No. 945
Sample No. L10 40.6 - 41.0

Melanocratic, aegirine-augite nepheline syenite.

Medium grained, massive, equigranular, allotriomorphic, with straight to curved grain boundaries. Magnetite is anhedral and disseminated. Magnetite is poikilitic in aegirine-augite. Aegirine-augite occurs as anhedral dark green grains. Nepheline forms anhedral grains with poikilitic aegirine-augite and potassium feldspar. Nepheline often is partially turbid from unidentified alteration. Potassium feldspar is orthoclase, which is roughly tabular in form, rarely twinned, and locally contains poikilitic pyroxene. Nepheline appears to be interstitial to feldspar. Map-unit 5b.

Reference No. 946
Sample No. L10 166.9 - 167.0

Malignite.

Fine to medium grained, massive, inequigranular-porphyritic-seriate, allotriomorphic, with curved grain boundaries. Minor biotite occurs as ragged grains on magnetite. Potassium feldspar

(orthoclase) is clear and may poikilitically enclose pyroxene and nepheline. Grains are anhedral and appear to be interstitial to pyroxene and nepheline. Magnetite is anhedral and disseminated throughout. Nepheline is generally fresh, and forms anhedral irregular grains which commonly are partially enclosed in potassium feldspar. Traces of cancrinite are present. Approximately 10 percent of the thin section is nepheline which is distinctly porphyritic. Aegirine-augite is dark green and forms anhedral grains. Minor myrmekite is present. Myrmekite consists of a fine grained wormy intergrowth of nepheline and potassium feldspar. The texture of the rock tends toward granoblastic. Map-unit 4a.

Reference No. 947
Sample No. L10 202.7 - 203.0

Feldspar-bearing ijolite.

Fine grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Texture tends toward granoblastic. Magnetite is anhedral and disseminated. Feldspar is clear, fresh orthoclase and commonly has myrmekite developed in portions of the grain. Myrmekite is common in some areas of the thin section and consists of wormy intergrowths of nepheline and potassium feldspar. Nepheline is fresh, anhedral, and interlocking with pyroxene. Some larger grains poikilitically enclose pyroxene and more rarely apatite. Aegirine-augite forms anhedral grains interlocking with nepheline. Biotite is reddish-brown and forms ragged grains marginal to pyroxene and magnetite. Map-unit 4a.

Reference No. 948
Sample No. L10 225.6 - 225.7

Malignite.

Fine grained, equigranular, massive, allotriomorphic, with curved grain boundaries. Nepheline is fresh and forms anhedral grains, poikilitically enclosing pyroxene and some apatite. Some of the larger grains are amoeboid and appear porphyroblastic. Biotite is minor and forms ragged grains in association with pyroxene and magnetite. Pyroxene is anhedral, dark green aegirine-augite. Poikilitic grains are rounded and bead-like. Myrmekite is common throughout the thin section, and occurs between nepheline grains and rimming orthoclase. Orthoclase is clear, anhedral, and interstitial to nepheline and pyroxene; it locally has myrmekite along edges. Map-unit 4a.

Reference No. 949
Sample No. L10 236.6 - 236.95

Malignite.

Fine grained, massive, equigranular to inequigranular-porphyritic-seriate, allotriomorphic, with curved grain boundaries. Texture tends towards granoblastic. Magnetite is anhedral and disseminated. Apatite is anhedral, elongate, scattered throughout. Traces of biotite are present. Myrmekite occurs throughout the thin section as wormy intergrowths of nepheline and potassium feldspar. Potassium feldspar (orthoclase) forms clear, colourless, anhedral grains with myrmekite along margins. Potassium feldspar appears to be interstitial to pyroxene and nepheline, and may partially enclose both. Porphyritic texture is due to relatively larger grains of nepheline which may compose up to 10 percent of the rock. Pyroxene is dark green aegirine-augite, anhedral and interlocking with nepheline. Map-unit 4a.

Reference No. 950
Sample No. L11 45.7 - 46.2

Leucocratic, aegirine-augite nepheline syenite.

Coarse grained, massive, equigranular to inequigranular-seriate, allotriomorphic, with straight to curved grain boundaries. Nepheline forms anhedral to subhedral grains interlocking with pyroxene; some cancrinite alteration is present. Pyroxene is anhedral, somewhat ragged aegirine-augite. Biotite forms ragged small grains along rims of some pyroxene grains. Magnetite forms anhedral grains in association with pyroxene and poikilitic grains in pyroxene. Potassium feldspar is a Carlsbad-twinned, very fine grained microperthite; it is anhedral and roughly tabular. Rare poikilitic inclusions of nepheline occur in feldspar. Traces of sodic plagioclase occur on margins of some potassium feldspar grains. Map-unit 5c.

Reference No. 951
Sample No. L12 78.2 - 78.5

Melanocratic, biotite - magnetite - carbonate - aegirine-augite syenite.

Fine to medium grained, massive, equigranular, allotriomorphic, with curved grain boundaries. Nepheline is totally altered to a very fine grained, felty sericitic or zeolitic mass. Nepheline may contain poikilitic pyroxene. Carbonate is anhedral and interstitial. Pyroxene is pale green, an-

hedral aegirine-augite; grains are crudely rounded in form. Biotite forms ragged dark reddish-brown grains which may enclose nepheline and pyroxene. Myrmekite is a fine-grained vermiform mixture of potassium feldspar and nepheline. Magnetite occurs as anhedral disseminated grains interlocking with pyroxene. Map-unit 5b.

Reference No. 952
Sample No. L12 476.7 - 477.1

Amphibole-bearing, biotite ijolite.

Fine grained, equigranular, massive, hypidiomorphic. Magnetite forms anhedral grains interlocking with pyroxene. Biotite forms anhedral tabular dark brown grains interlocking with pyroxene. Biotite locally encloses pyroxene. Pyroxene forms pale green, anhedral to euhedral grains. Nepheline is fresh or altered to cancrinite. Poikilitic grains of pyroxene are enclosed in nepheline, and nepheline appears interstitial to pyroxene. Nepheline sometimes contains tiny poikilitic inclusions of apatite oriented parallel to C-axis. Map-unit 4a.

Reference No. 953
Sample No. L13 31.2 - 32.0

Amphibole - pyroxene nepheline syenite.

Medium to coarse grained, massive, equigranular, allotriomorphic, with curved to straight grain boundaries. Sericite occurs as an aggregate of interlocking anhedral grains. Pyroxene is dark green aegirine-augite thickly mantled with very dark green sodic amphibole. Amphibole appears to replace pyroxene. Plagioclase occurs in trace amounts marginal to larger perthite grains. Potassium feldspar is a microperthite with very fine grained, stringy texture. Crystals display Carlsbad twinning; they are anhedral in form, somewhat tabular, and sometimes contain rounded grains or poikilitic inclusions of altered nepheline. Nepheline forms anhedral irregular grains. Cancrinite occurs along grain margins and between grains of nepheline and feldspar. Turbid very fine grained alteration occurs along cleavages of most of the nepheline. Map-unit 5c.

TABLE A-2. MAJOR ELEMENT ANALYSES (WEIGHT PERCENT) OF WHOLE-ROCK SAMPLES FROM THE LACKNER LAKE CARBONATITE COMPLEX.

	UNIT 3A						
Ref. No.	897	899	901	903	904	905	906
SiO_2	46.9	46.1	46.3	46.7	49.2	46.2	46.6
Al_2O_3	16.9	16.5	15.6	15.7	16.9	18.5	16.6
Fe_2O_3	3.38	2.91	3.25	2.57	3.13	3.19	4.91
FeO	6.32	6.48	6.98	7.23	5.98	5.73	5.49
MgO	2.96	3.22	3.11	3.42	1.93	2.77	3.33
CaO	9.35	10.5	10.2	10.8	8.07	8.51	8.66
Na_2O	9.32	8.93	8.68	8.26	7.81	10.0	10.2
K_2O	3.67	3.29	2.90	3.40	5.36	3.83	2.69
TiO_2	0.13	0.09	0.17	0.11	0.12	0.12	0.21
P_2O_5	0.05	0.49	0.07	0.28	0.41	0.04	0.04
S	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MnO	0.56	0.58	0.55	0.61	0.49	0.51	0.45
CO_2	0.42	0.34	0.80	0.38	0.34	0.34	0.40
H_2O+	0.19	0.16	0.13	N.D.	0.02	N.D.	0.20
H_2O-	0.26	0.18	0.22	0.22	0.29	0.27	0.24
Total	100.40	99.80	99.00	99.40	100.10	100.00	100.00

	UNIT 3A						UNIT 4A
Ref. No.	917	918	919	920	921	922	885
SiO_2	46.6	46.5	46.8	43.4	46.4	26.6	37.3
Al_2O_3	16.0	16.9	15.8	17.0	17.6	8.40	12.5
Fe_2O_3	3.41	2.81	4.21	5.48	3.33	23.6	10.75
FeO	6.57	6.66	6.48	7.40	5.98	19.5	3.74
MgO	3.69	3.56	3.34	2.71	3.05	2.23	5.63
CaO	10.2	9.27	9.44	8.37	9.22	7.82	14.9
Na_2O	9.02	8.95	9.55	9.25	9.47	3.51	5.29
K_2O	3.01	3.40	2.44	3.50	3.58	1.43	3.34
TiO_2	0.15	0.18	0.19	0.79	0.12	3.88	1.49
P_2O_5	0.03	0.04	0.05	0.04	0.05	0.20	2.62
S	<0.01	0.01	<0.01	<0.01	<0.01	0.01	<0.01
MnO	0.52	0.49	0.51	0.56	0.54	1.06	0.45
CO_2	0.60	0.34	0.27	0.26	0.25	0.18	0.52
H_2O+	0.07	0.03	0.14	0.07	0.04	0.30	0.39
H_2O-	0.25	0.27	0.27	0.26	0.25	0.03	0.20
Total	100.10	99.40	99.50	99.20	100.10	98.70	99.10

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
897	LW 30-5	917	LW 30-28
899	LW 30-8	918	LW 30-30
901	LW 30-9	919	LW 30-33
903	LW 30-10B	920	LW 30-34
904	LW 30-12	921	LW 30-36
905	LW 30-13	922	BC 13-1C
906	LW 30-14	885	LR 23-13

TABLE A-2 continued.

	UNIT 4A						
Ref. No.	847	848	854	855	857	861	865
SiO_2	37.8	41.1	52.1	51.9	48.2	53.3	39.2
Al_2O_3	12.8	15.0	22.2	20.8	16.8	20.0	13.2
Fe_2O_3	7.77	5.66	3.15	3.04	3.46	3.37	7.68
FeO	6.15	6.07	2.58	4.57	8.14	3.66	7.31
MgO	6.34	5.75	0.60	0.32	2.04	0.54	3.85
CaO	14.2	9.73	2.17	2.58	6.08	2.83	11.5
Na_2O	4.42	6.41	8.75	7.14	5.89	7.30	4.43
K_2O	3.44	4.06	7.63	7.23	5.36	7.24	4.22
TiO_2	1.46	1.15	0.31	0.25	1.13	0.19	1.41
P_2O_5	2.68	1.74	0.16	0.12	0.63	0.13	1.74
S	<0.01	<0.01	0.05	0.02	0.04	<0.01	0.03
MnO	0.37	0.58	0.19	0.23	0.37	0.21	0.49
CO_2	0.34	0.38	0.46	0.34	0.26	0.28	1.68
H_2O+	0.66	0.95	0.29	0.32	0.48	0.24	0.27
H_2O-	0.22	0.22	0.27	0.25	0.25	0.21	0.24
Total	98.70	98.80	100.90	99.10	99.10	99.50	97.20

	UNIT 4A						
Ref. No.	864	867	869	907	909	929	933
SiO_2	51.6	41.1	50.6	45.4	47.1	46.09	43.67
Al_2O_3	21.1	14.9	22.4	17.0	15.3	16.99	17.89
Fe_2O_3	3.00	3.62	1.65	4.33	3.35	2.93	2.83
FeO	3.24	6.65	2.74	5.65	6.98	7.08	5.47
MgO	0.55	6.96	0.66	2.95	3.85	3.16	3.30
CaO	2.94	11.2	2.91	9.22	10.3	10.22	10.59
Na_2O	8.48	5.75	9.33	9.76	8.65	8.86	9.24
K_2O	7.10	4.00	6.89	3.09	2.63	3.59	3.74
TiO_2	0.21	1.10	0.17	0.13	0.17	0.08	0.06
P_2O_5	0.15	1.20	0.17	0.47	0.03	0.02	0.83
S	0.02	<0.01	<0.01	0.03	<0.01	<0.01	0.01
MnO	0.19	0.29	0.20	0.48	0.47	0.60	0.47
CO_2	0.28	0.74	0.50	0.30	0.38	0.22	0.59
H_2O+	N.D.	0.57	0.38	0.07	0.15	0.07	0.40
H_2O-	0.26	0.23	0.30	0.24	0.26	0.19	0.23
Total	99.10	98.30	98.90	99.10	99.60	100.10	99.30

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
847	LW 22-1	864	LW 22-22B
848	LW 22-2	867	LW 22-25
854	LW 22-10	869	LW 22-29
855	LW 22-11	907	LW 30-16
857	LW 22-13	909	LW 30-18A
861	LW 22-18	929	L1 139.0-139.2
865	LW 22-22A	933	L2 136.8-137.2

TABLE A-2 continued.

	UNIT 4A						
Ref. No.	**934**	**935**	**936**	**937**	**940**	**944**	**946**
SiO_2	44.22	43.41	43.43	44.00	37.26	42.21	42.05
Al_2O_3	12.62	12.22	12.52	12.37	12.03	12.58	16.75
Fe_2O_3	2.69	6.06	12.25	6.11	8.45	2.96	6.94
FeO	7.65	4.34	2.85	9.18	7.00	8.05	5.31
MgO	4.36	3.83	3.87	3.90	6.02	3.07	3.48
CaO	14.64	12.88	12.36	12.45	12.87	16.25	9.49
Na_2O	6.57	6.86	6.93	6.79	5.95	6.50	6.64
K_2O	2.57	2.47	2.53	2.53	3.19	2.56	4.97
TiO_2	0.11	0.61	0.49	0.58	1.33	0.10	0.93
P_2O_5	1.68	0.97	0.34	0.60	2.03	2.03	1.07
S	0.02	<0.01	-	0.01	0.05	0.01	<0.01
MnO	0.59	0.70	0.73	0.71	0.44	0.53	0.40
CO_2	0.22	0.15	-	0.18	0.22	0.48	0.51
H_2O+	N.D.	N.D.	N.D.	N.D.	0.03	N.D.	N.D.
H_2O-	0.21	0.18	-	0.15	0.21	0.26	0.31
Total	98.20	99.70	98.3	99.60	97.10	97.60	98.90

	UNIT 4A				UNIT 4B		
Ref. No.	**947**	**948**	**949**	**952**	**932**	**856**	**862**
SiO_2	41.19	41.90	42.42	39.26	52.78	51.5	52.5
Al_2O_3	16.68	17.07	16.73	11.03	18.33	18.6	19.6
Fe_2O_3	7.35	6.56	7.70	3.29	1.25	4.73	3.66
FeO	5.31	5.07	4.43	7.41	2.90	4.57	4.16
MgO	3.50	3.33	3.41	10.22	1.27	0.64	0.58
CaO	9.82	9.99	9.36	17.24	4.91	3.36	3.20
Na_2O	7.27	7.29	6.56	2.60	5.26	7.13	7.20
K_2O	4.46	4.68	5.20	2.08	9.15	6.79	7.02
TiO_2	0.90	0.86	0.87	1.60	0.09	0.29	0.23
P_2O_5	1.12	1.14	1.19	1.20	0.87	0.16	0.11
S	<0.01	<0.01	<0.01	0.12	0.01	0.04	0.03
MnO	0.41	0.41	0.40	0.21	0.19	0.23	0.25
CO_2	0.65	0.62	0.66	1.57	0.62	0.64	0.28
H_2O+	N.D.	N.D.	0.0	0.05	0.49	0.34	0.14
H_2O-	0.38	0.31	0.34	0.43	0.19	0.25	0.26
Total	99.10	99.20	99.30	98.30	98.30	99.30	99.20

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
934	L2 150.65-151.0	947	L10 202.7-203.0
935	L2 218.6-218.8	948	L10 225.6-225.7
936	L2 223.6-223.8	949	L10 236.6-236.95
937	L2 243.3-243.6	952	L12 476.7-477.1
940	L5 91.1-91.3	932	L2 117.65
944	L9 111.3-111.65	856	LW 22-12A
946	L10 166.9-167.0	862	LW 22-19

TABLE A-2 continued.

	UNIT 4B			UNIT 4C				
Ref. No.	866	868	908	879	883	886	887	893
SiO_2	52.3	52.7	50.7	54.10	52.2	40.8	52.6	48.2
Al_2O_3	18.8	19.9	17.4	15.30	19.5	15.7	20.0	19.5
Fe_2O_3	4.91	3.26	5.14	12.32	3.95	7.13	3.07	2.45
FeO	4.16	3.57	5.73	1.07	3.57	4.57	3.49	5.82
MgO	0.67	0.55	0.92	0.57	0.62	4.61	0.60	1.90
CaO	3.81	3.11	4.13	1.70	3.22	11.3	3.29	5.11
Na_2O	7.27	7.31	6.44	4.31	7.80	7.67	8.02	8.39
K_2O	6.82	7.41	6.89	6.96	6.96	3.00	7.15	5.53
TiO_2	0.31	0.30	0.36	0.66	0.27	1.08	0.19	0.61
P_2O_5	0.20	0.16	0.15	0.15	0.13	1.30	0.20	0.46
S	0.02	0.02	0.04	0.01	0.02	<0.01	0.07	0.01
MnO	0.29	0.21	0.41	0.41	0.24	0.35	0.22	0.30
CO_2	0.26	0.30	0.30	0.24	0.40	1.38	0.78	0.26
H_2O+	0.18	0.28	0.07	0.04	0.04	0.29	0.19	0.32
H_2O-	0.22	0.25	0.18	0.24	0.27	0.18	0.39	0.21
Total	100.20	99.30	98.90	98.10	99.20	99.40	100.30	99.10

	UNIT 4C					UNIT 5A		
Ref. No.	851	876	877	880	915	884	884*	888
SiO_2	50.1	52.0	51.9	46.3	49.0	52.0	51.70	51.8
Al_2O_3	21.1	19.6	20.0	14.6	17.2	20.0	20.10	21.9
Fe_2O_3	2.89	4.07	3.22	3.99	9.31	3.58	3.81	2.84
FeO	3.41	3.66	3.91	8.56	1.08	3.74	3.50	2.99
MgO	0.73	0.51	0.54	3.05	0.93	0.62	0.60	0.98
CaO	3.04	3.10	3.41	9.15	4.65	3.21	3.17	2.73
Na_2O	8.72	7.88	8.16	6.35	6.51	8.12	7.96	4.74
K_2O	6.88	6.94	7.17	4.20	7.00	7.02	7.10	7.79
TiO_2	0.29	0.24	0.21	1.00	0.38	0.29	0.29	0.27
P_2O_5	0.22	0.16	0.16	0.90	0.41	0.21	0.22	0.17
S	0.05	0.03	0.02	0.02	<0.01	0.02	0.01	0.01
MnO	0.23	0.27	0.22	0.43	0.29	0.22	0.22	0.19
CO_2	0.38	0.38	0.50	0.32	0.60	0.24	0.22	0.26
H_2O+	0.20	0.09	0.26	0.57	0.08	0.08	0.09	2.32
H_2O-	0.26	0.20	0.24	0.30	0.24	0.26	0.26	0.37
Total	98.50	99.10	99.90	99.70	97.70	99.60	99.30	99.40

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

* Duplicate sample

Reference No.	Sample No.
866	LW 22-23
868	LW 22-26
908	LW 30-17
879	LW 23-7
883	LR 23-11
886	LR 23-14
887	LR 23-15
893	LR 23-23

Reference No.	Sample No.
851	LW 22-7
876	LW 23-5
877	LW 23-6
880	LW 23-9
915	LW 30-23
884	LR 23-12A
884*	LR 23-12B
888	LR 23-16

TABLE A-2 continued.

	UNIT 5A						
Ref. No.	**889**	**891**	**850**	**852**	**853**	**849**	**863**
SiO_2	51.1	52.9	50.5	49.8	50.5	51.9	54.4
Al_2O_3	21.4	22.0	20.8	20.9	21.7	19.8	19.1
Fe_2O_3	3.01	2.16	3.82	3.25	2.92	4.08	6.34
FeO	3.24	2.49	3.82	3.57	2.74	3.99	2.66
MgO	0.67	0.39	0.79	0.80	0.50	0.52	0.12
CaO	2.84	1.77	3.08	2.37	2.57	3.23	0.85
Na_2O	8.84	8.23	8.12	8.69	8.99	7.57	6.33
K_2O	6.83	7.56	6.29	6.62	6.88	7.07	7.65
TiO_2	0.25	0.35	0.44	0.29	0.25	0.23	0.14
P_2O_5	0.21	0.10	0.18	0.16	0.18	0.37	0.13
S	0.04	0.02	0.05	0.05	0.05	0.03	<0.01
MnO	0.21	0.14	0.28	0.23	0.19	0.23	0.27
CO_2	0.42	0.34	0.26	0.52	0.70	0.26	0.32
H_2O+	0.13	0.15	0.70	0.45	0.14	0.15	0.03
H_2O-	0.22	0.24	0.30	0.22	0.25	0.22	0.26
Total	99.40	98.80	99.40	97.90	98.60	99.70	98.60

	UNIT 5A			UNIT 5B			
Ref. No.	**872**	**911**	**914**	**890**	**892**	**881**	**910**
SiO_2	47.9	50.6	53.8	51.5	47.6	45.9	48.4
Al_2O_3	17.9	19.4	19.9	22.4	18.6	17.4	21.5
Fe_2O_3	3.07	2.11	3.20	2.21	2.50	2.38	2.12
FeO	8.31	4.74	4.24	2.83	6.48	7.40	4.99
MgO	1.76	1.51	0.50	0.56	2.26	3.45	1.30
CaO	4.83	4.08	3.50	2.53	7.14	7.77	3.31
Na_2O	6.67	4.97	7.68	9.12	4.40	7.32	9.08
K_2O	5.45	7.83	7.23	7.07	5.36	4.88	6.35
TiO_2	1.02	0.89	0.18	0.20	0.58	0.87	0.36
P_2O_5	0.59	0.51	0.17	0.16	0.53	0.68	0.05
S	0.01	0.02	0.04	0.01	0.02	0.05	0.04
MnO	0.38	0.17	0.23	0.16	0.34	0.33	0.25
CO_2	0.22	0.52	0.44	0.26	0.36	0.36	0.60
H_2O+	0.76	0.25	0.0	0.08	2.22	0.56	0.33
H_2O-	0.25	0.28	0.19	0.27	0.39	0.25	0.21
Total	99.10	97.90	101.30	99.40	98.80	99.60	98.90

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
889	LR 23-17	872	LW 23-1
891	LR 23-19	911	LW 30-20A
850	LW 22-5	914	LW 30-22
852	LW 22-8	890	LR 23-18
853	LW 22-9	892	LR 23-20
849	LW 22-4B	881	LW 23-10
863	LW 22-20	910	LW 30-18B

TABLE A-2 continued.

	UNIT 5B				UNIT 5C		
Ref. No.	912	913	945	951	845	846	882
SiO_2	53.0	50.9	44.68	44.60	53.0	51.5	47.8
Al_2O_3	22.1	22.3	15.57	13.79	23.7	24.7	22.4
Fe_2O_3	1.36	1.87	9.47	5.41	1.16	1.65	1.86
FeO	3.74	4.32	6.68	5.88	1.75	1.66	3.99
MgO	0.40	0.71	1.63	5.13	0.18	0.16	1.02
CaO	1.66	2.25	5.61	12.34	0.93	0.84	3.08
Na_2O	7.79	8.51	3.86	1.15	9.16	9.63	8.76
K_2O	7.57	6.91	6.57	5.52	7.64	7.30	6.36
TiO_2	0.36	0.39	1.08	0.77	0.19	0.13	0.66
P_2O_5	0.14	0.18	0.38	0.04	0.09	0.11	0.40
S	0.02	0.01	0.05	0.32	0.01	<0.01	0.03
MnO	0.15	0.22	0.38	0.47	0.09	0.09	0.18
CO_2	0.48	0.46	0.44	1.94	0.30	0.56	0.52
H_2O+	0.14	0.03	N.D.	0.93	0.41	0.82	0.12
H_2O-	0.27	0.24	0.26	0.50	0.32	0.37	0.25
Total	99.20	99.30	96.70	98.80	98.90	99.50	97.40

	UNIT 5C						
Ref. No.	858	859	860	870	870*	873	874
SiO_2	49.8	51.8	51.2	49.6	53.1	46.6	49.3
Al_2O_3	23.1	24.1	18.7	18.6	23.5	17.0	23.1
Fe_2O_3	1.00	1.49	1.83	9.01	1.36	3.49	1.81
FeO	3.82	1.78	5.32	2.16	2.08	7.48	2.91
MgO	0.93	0.10	1.42	0.80	0.46	2.59	0.81
CaO	2.54	0.71	3.99	3.28	1.95	7.58	1.77
Na_2O	8.70	9.72	5.00	10.9	9.16	7.11	9.30
K_2O	6.58	7.29	6.96	2.92	7.24	4.95	7.17
TiO_2	0.56	0.14	0.75	0.33	0.14	0.85	0.48
P_2O_5	0.28	0.08	0.35	0.31	0.17	0.70	0.19
S	0.02	0.01	0.04	0.03	0.02	0.02	<0.01
MnO	0.15	0.08	0.22	0.33	0.15	0.38	0.16
CO_2	0.32	0.34	0.44	0.30	0.36	0.44	0.34
H_2O+	0.63	0.53	0.67	0.26	0.46	0.51	0.66
H_2O-	0.26	0.26	0.20	0.26	0.31	0.21	0.28
Total	98.70	98.40	97.10	99.10	100.50	99.90	98.30

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

* Duplicate sample

Reference No.	Sample No.	Reference No.	Sample No.
912	LW 30-20B	858	LW 22-15
913	LW 30-21	859	LW 22-16
945	L10 40.6-41.0	860	LW 22-16A
951	L12 78.2-78.5	870	LW 22-31A
845	LW 12-1	870*	LW 22-31B
846	LW 12-2	873	LW 23-2
882	LR 23-10	874	LW 23-3

TABLE A-2 continued.

	UNIT 5C						
Ref. No.	**875**	**894**	**895**	**896**	**898**	**902**	**916**
SiO_2	46.4	50.5	46.9	49.3	57.7	51.1	50.4
Al_2O_3	14.9	23.6	24.2	23.8	20.9	23.5	21.7
Fe_2O_3	3.24	1.92	1.32	1.83	0.68	2.07	2.92
FeO	9.06	2.08	2.08	1.75	1.25	1.91	2.99
MgO	3.02	0.44	0.60	0.31	0.41	0.32	0.53
CaO	8.50	1.87	3.15	1.95	0.60	1.15	2.72
Na_2O	6.24	10.3	11.3	10.2	5.37	9.54	8.98
K_2O	4.51	6.91	6.54	7.31	10.1	7.40	6.54
TiO_2	1.08	0.28	0.26	0.25	0.22	0.28	0.62
P_2O_5	0.84	0.11	0.51	0.10	0.11	0.11	0.22
S	0.02	0.02	<0.01	0.03	0.02	0.02	0.02
MnO	0.42	0.11	0.11	0.09	0.06	0.10	0.19
CO_2	0.24	0.66	0.98	0.94	0.42	0.54	0.48
H_2O+	0.71	0.36	0.32	0.27	0.29	0.26	0.42
H_2O-	0.25	0.27	0.25	0.21	0.26	0.27	0.28
Total	99.40	99.40	98.50	98.30	98.40	98.60	99.00

	UNIT 5C						
Ref. No.	**930**	**931**	**938**	**939**	**941**	**942**	**943**
SiO_2	50.05	51.79	50.64	51.29	51.27	52.50	53.04
Al_2O_3	19.84	22.37	23.79	21.35	21.53	21.68	21.81
Fe_2O_3	2.04	2.35	0.45	2.37	2.38	1.62	1.73
FeO	4.03	2.82	1.93	2.74	2.66	2.33	2.98
MgO	0.94	0.39	0.29	0.41	0.32	0.28	0.28
CaO	4.67	2.31	1.30	2.49	2.52	2.07	2.19
Na_2O	6.84	8.17	7.54	8.44	8.23	7.72	7.65
K_2O	8.04	8.00	10.47	7.85	7.97	8.41	8.45
TiO_2	0.23	0.28	0.17	0.31	0.26	0.14	0.18
P_2O_5	0.39	0.09	0.21	0.03	0.13	0.03	0.06
S	<0.01	0.02	0.05	0.02	0.02	0.03	0.05
MnO	0.22	0.15	0.08	0.16	0.15	0.13	0.15
CO_2	0.70	0.59	1.57	0.95	1.28	0.88	0.88
H_2O+	0.16	0.04	0.37	0.13	0.17	0.18	0.12
H_2O-	0.10	0.26	0.15	0.08	0.24	0.19	0.23
Total	98.30	99.60	99.00	98.60	99.10	98.20	99.80

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
875	LW 23-4	930	L1 168.1-168.85
894	LW 30-2	931	L2 79.0-79.8
895	LW 30-3	938	L2 271.6-272.0
896	LW 30-4	939	L5 46.5-46.9
898	LW 30-6	941	L5 214.3-214.9
902	LW 30-10A	942	L6 51.3-51.7
916	LW 30-25	943	L8 169.2-169.75

TABLE A-2 continued.

	UNIT 5C		UNIT 6					MISC.
Ref. No.	950	953	924	925	926	927	928	923
SiO_2	50.05	52.29	1.66	3.91	2.10	5.02	10.9	55.90
Al_2O_3	23.75	24.22	0.31	0.18	0.19	0.21	0.40	21.00
Fe_2O_3	1.85	0.67	7.68	2.00	0.95	11.02	3.41	1.25
FeO	2.90	1.69	6.23	2.91	1.83	7.73	5.65	2.24
MgO	0.25	0.12	0.21	0.40	0.27	0.41	1.18	0.85
CaO	1.96	1.02	44.0	47.4	50.6	37.00	40.00	2.72
Na_2O	9.64	9.61	0.50	0.54	0.34	1.39	0.97	5.80
K_2O	7.16	7.86	0.02	0.04	0.04	0.08	0.19	8.73
TiO_2	0.18	0.12	0.60	0.20	0.02	0.51	0.38	0.17
P_2O_5	0.12	0.07	4.52	8.72	2.34	8.00	11.2	0.02
S	0.01	0.01	0.34	0.23	0.21	0.93	0.43	0.01
MnO	0.15	0.07	0.28	0.24	0.24	0.46	0.34	0.21
CO_2	0.70	0.77	30.3	28.5	39.2	23.3	18.9	0.18
H_2O+	0.0	0.15	N.D.	0.04	N.D.	0.01	0.09	0.20
H_2O-	0.33	0.39	0.28	0.28	0.28	0.25	0.26	0.04
Total	99.10	99.10	96.9	95.60	98.60	96.3	94.3	99.80

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
950	L11 45.7-46.2	926	Lac 3
953	L13 31.2-32.0	927	Lac 4
924	Lac 1	928	Lac 5
925	Lac 2	923	BC13-5B

TABLE A-3. TRACE ELEMENT ANALYSES (PPM) OF WHOLE-ROCK SAMPLES FROM THE LACKNER LAKE ALKALIC ROCK COMPLEX

	UNIT 3A						
Ref. No.	**897**	**899**	**901**	**903**	**904**	**905**	**906**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	330	200	460	200	1000	190	70
Be	25	20	25	20	20	20	25
Bi							
Co	8	7	8	7	7	7	7
Cr	<5	<5	5	<5	<5	5	<5
Cu	<5	<5	10	<5	<5	<5	<5
Ga	9	9	9	9	15	15	15
Hg							
Li	6	6	9	5	4	4	8
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	150	350	<30	<30	250	250	<30
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	35	<10	<10	<10	<10	<10
Rb	110	90	70	100	210	140	80
Sb							
Sc	<5	<5	<5	<5	<5	<5	<5
Sn	3	5	3	<3	3	4	9
Sr	700	800	1500	600	600	500	500
Ti							
V	30	20	35	20	15	20	60
Y	25	40	30	35	40	<10	<10
Zn	240	230	230	240	185	220	205
Zr	800	600	600	1000	900	1000	900
La	<100	<100	<100	<100	<100	<100	<100
Nd	<100	<100	<100	<100	<100	<100	<100
Ce	70	180	50	120	140	50	70

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
897	LW 30-5	904	LW 30-12
899	LW 30-8	905	LW 30-13
901	LW 30-9	906	LW 30-14
903	LW 30-10B		

TABLE A-3 continued.

	UNIT 3A						UNIT 4A
Ref. No.	917	918	919	920	921	922	885
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As						<1	
Ba	60	200	100	140	180	<150	1680
Be	25	20	20	20	180	5	7
Bi							
Co	10	10	10	10	9	30	40
Cr	<5	<5	<5	<5	<5	15	<5
Cu	<5	5	15	15	9	6	20
Ga	9	9	15	15	9	10	10
Hg							
Li	4	6	6	3	4	<20	60
Mn							
Mo	<1	<1	<1	<1	<1	<10	<1
Nb	200	300	<30	700	45	1000	200
Ni	<5	<5	<5	<5	<5	20	30
Pb	<10	10	<10	30	11	<10	20
Rb	90	90	60	100	90	50	120
Sb						<4	
Sc	<5	<5	15	<5	15	<20	10
Sn	4	3	8	5	<3	10	<3
Sr	400	800	500	500	600	200	2000
Ti							
V	30	35	45	60	35	150	100
Y	15	20	25	20	20	<20	100
Zn	200	195	195	320	178	1040	140
Zr	600	1000	1500	600	300	600	200
La	<100	<100	<100	<100	<100	<10	500
Nd	<100	<100	<100	<100	<100	<300	400
Ce	60	80	60	190	130	<500	1100

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
917	LW 30-28	921	LW 30-36
918	LW 30-30	922	BC 13-1C
919	LW 30-33	885	LR 23-13
920	LW 30-34		

TABLE A-3 continued.

	UNIT 4A						
Ref. No.	**847**	**848**	**854**	**855**	**857**	**861**	**865**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	2040	2220	1820	310	2040	1120	3710
Be	9	25	6	9	6	4	15
Bi							
Co	40	35	8	7	15	9	30
Cr	25	170	<5	<5	<5	9	70
Cu	125	9	10	10	20	10	70
Ga	9	10	8	9	8	10	8
Hg							
Li	15	25	7	8	5	6	25
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	250	250	500	200	400	80	300
Ni	50	65	<5	<5	<5	<5	<5
Pb	15	20	15	15	10	<10	30
Rb	100	150	170	110	90	170	150
Sb							
Sc	15	15	<5	<5	<5	<5	<5
Sn	<3	3	<3	<3	<3	<3	<3
Sr	3000	1500	2000	900	2500	800	7000
Ti							
V	200	150	15	<10	20	<10	150
Y	70	60	<10	<10	45	<10	80
Zn	140	340	75	100	150	60	230
Zr	300	300	250	200	300	200	400
La	500	500	<100	<100	300	<100	500
Nd	300	350	<100	<100	250	<100	350
Ce	1060	850	220	170	560	90	920

Notes:
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
847	LW 22-1	857	LW 22-13
848	LW 22-2	861	LW 22-18
854	LW 22-10	865	LW 22-22A
855	LW 22-11		

TABLE A-3 continued.

	UNIT 4A						
Ref. No.	864	867	869	907	909	929	933
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1600	1830	2500	100	80	90	130
Be	5	9	9	25	15	10	15
Bi							
Co	<5	30	<5	7	8	15	15
Cr	15	20	6	15	85	5	6
Cu	15	20	8	8	5	5	6
Ga	15	8	8	8	9	8	10
Hg							
Li	4	25	10	6	6	4	5
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	150	100	250	600	<30	<30	<30
Ni	<5	55	<5	<5	10	<5	<5
Pb	<10	<10	15	25	<10	<10	10
Rb	170	120	170	80	60	70	60
Sb							
Sc	<5	15	<5	8	20	<5	<5
Sn	<3	<3	<3	9	4	<3	<3
Sr	900	1500	2000	700	500	450	1000
Tl							
V	<10	150	<10	50	100	25	25
Y	<10	60	25	40	<10	<10	40
Zn	55	95	95	220	160	195	160
Zr	300	200	250	700	800	700	250
La	<100	300	<100	<100	<100	<100	<100
Nd	<100	250	<100	<100	<100	<100	<100
Ce	140	620	250	190	90	40	220

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
864	LW 22-22B	909	LW 30-18A
867	LW 22-25	929	L1 139.0-139.2
869	LW 22-29	933	L2 136.8-137.2
907	LW 30-16		

TABLE A-3 continued.

	UNIT 4A						
Ref. No.	**934**	**935**	**936**	**937**	**940**	**944**	**946**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	50	30	30	30	720	110	2400
Be	15	9	8	9	10	20	8
Bi							
Co	15	15	20	15	45	15	30
Cr	9	55	50	55	20	5	25
Cu	9	7	8	10	1840	7	10
Ga	15	10	15	10	10	15	9
Hg							
Li	3	4	4	4	18	6	6
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	1500	400	1000	500	100	250	100
Ni	<5	7	9	9	45	<5	20
Pb	15	15	20	20	<10	20	10
Rb	60	50	60	60	120	50	140
Sb							
Sc	15	<5	<5	5	15	<5	<5
Sn	<3	3	3	3	<3	5	<3
Sr	1000	600	500	600	3000	1500	2500
Ti							
V	30	50	45	60	150	30	80
Y	80	40	25	25	70	80	60
Zn	220	260	240	270	185	195	160
Zr	3000	600	1000	700	300	1000	250
La	200	<100	<100	<100	300	350	150
Nd	200	100	<100	<100	200	200	100
Ce	480	320	180	260	850	830	480

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
934	L2 150.65-151.0	940	L5 91.1-91.3
935	L2 218.6-218.8	944	L9 111.3-111.65
936	L2 223.6-223.8	946	L10 166.9-167.0
937	L2 243.3-243.6		

TABLE A-3 continued.

	UNIT 4A				UNIT 4B		
Ref. No.	947	948	949	952	932	856	862
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	670	1400	2300	1000	3000	1040	920
Be	8	8	9	4	5	6	4
Bi							
Co	30	30	30	50	9	7	<5
Cr	25	30	45	840	7	35	15
Cu	6	8	10	65	<5	10	10
Ga	8	9	8	7	9	9	15
Hg							
Li	5	5	6	8	5	8	5
Mn							
Mo	<1	5	<1	<1	<1	<1	<1
Nb	40	<30	100	100	<30	100	90
Ni	20	20	20	155	<5	5	<5
Pb	<10	10	<10	10	<10	15	10
Rb	170	180	160	60	290	130	160
Sb							
Sc	5	5	<5	40	<5	<5	<5
Sn	<3	<3	<3	<3	<3	<3	<3
Sr	2500	3000	3000	1500	1000	1500	900
Ti							
V	70	80	50	150	20	<10	<10
Y	70	70	70	35	30	<10	<10
Zn	160	175	165	85	65	75	80
Zr	250	250	250	250	200	200	200
La	<100	150	150	100	<100	<100	<100
Nd	100	100	150	<100	<100	<100	<100
Ce	430	390	380	470	130	220	200

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
947	L10 202.7-203.0	932	L2 117.65
948	L10 225.6-225.7	856	LW 22-12A
949	L10 236.6-236.95	862	LW 22-19
952	L12 476.7-477.1		

TABLE A-3 continued.

	UNIT 4B			UNIT 4C				
Ref. No.	866	868	908	879	883	886	887	893
Ag	<1	<1	<1	<1	<1	<1	<1	<1
Au								
As								
Ba	1060	1200	950	4800	940	1640	1100	1660
Be	5	4	5	15	6	15	10	15
Bi								
Co	<5	<5	6	15	10	30	8	15
Cr	15	10	50	<5	15	60	9	30
Cu	15	10	15	10	10	15	30	15
Ga	9	10	10	15	15	9	15	10
Hg								
Li	6	6	<3	6	4	20	4	15
Mn								
Mo	<1	<1	<1	<1	<1	<1	<1	<1
Nb	<30	<30	250	1000	100	200	<30	300
Ni	<5	<5	20	<5	5	30	6	15
Pb	<10	<10	<10	50	<10	30	<10	20
Rb	170	170	180	150	170	120	170	150
Sb								
Sc	<5	<5	<5	<5	<5	10	<5	<5
Sn	<3	<3	5	9	<3	<3	<3	<3
Sr	900	900	1000	6000	900	2500	800	1500
Ti								
V	20	<10	20	40	20	150	20	40
Y	<10	<10	<10	30	10	70	<10	40
Zn	95	75	105	380	75	130	75	175
Zr	300	150	500	1500	450	150	300	300
La	<100	<100	<100	100	<100	350	<100	200
Nd	<100	<100	<100	150	<100	250	<100	150
Ce	130	110	190	470	210	760	280	530

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
866	LW 22-23	883	LR 23-11
868	LW 22-26	886	LR 23-14
908	LW 30-17	887	LR 23-15
879	LW 23-7	893	LR 23-23

TABLE A-3 continued.

	UNIT 4C					UNIT 5A		
Ref. No.	851	876	877	880	915	884	884*	888
Ag	<1	<1	<1	<1	<1	<1	<1	<1
Au								
As								
Ba	1760	1020	960	1860	4500	1000	880	2180
Be	7	7	5	9	9	7	7	7
Bi								
Co	10	<5	<5	20	9	9	9	8
Cr	10	15	15	35	7	15	15	5
Cu	10	15	10	30	5	9	8	10
Ga	8	15	15	7	15	15	15	10
Hg								
Li	8	5	4	10	10	6	6	80
Mn								
Mo	<1	<1	<1	<1	<1	<1	<1	<1
Nb	150	70	80	250	400	100	<30	250
Nl	5	<5	<5	15	<5	<5	<5	<5
Pb	<10	<10	<10	<10	15	30	55	<10
Rb	150	180	190	80	250	170	170	15
Sb								
Sc	<5	<5	<5	6	<5	<5	<5	<5
Sn	<3	<3	<3	<3	4	3	3	<3
Sr	2000	800	700	3500	3500	700	800	2000
Ti								
V	20	15	20	70	<10	20	20	15
Y	<10	<10	<10	50	20	<10	<10	<10
Zn	90	95	70	185	200	80	80	80
Zr	200	250	300	300	600	250	250	300
La	<100	<100	<100	350	<100	<100	<100	<100
Nd	<100	<100	<100	300	<100	<100	<100	<100
Ce	190	250	140	640	60	160	270	380

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

*Duplicate sample

Reference No.	Sample No.	Reference No.	Sample No.
851	LW 22-7	915	LW 30-23
876	LW 23-5	884	LR 23-12A
877	LW 23-6	884*	LR 23-12B
880	LW 23-9	888	LR 23-16

TABLE A-3 continued.

	UNIT 5A						
Ref. No.	**889**	**891**	**850**	**852**	**853**	**849**	**863**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1820	1380	1960	1540	1560	860	1020
Be	7	6	8	10	8	4	7
Bi							
Co	9	7	10	10	7	7	<5
Cr	7	<5	15	25	8	7	<5
Cu	10	6	15	10	10	15	<5
Ga	10	9	10	9	9	15	9
Hg							
Li	6	4	15	10	8	4	3
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	150	70	350	350	250	<30	450
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	15	<10	15	15	<10	15
Rb	16	15	130	150	150	170	200
Sb							
Sc	<5	<5	<5	<5	<5	<5	<5
Sn	<3	<3	<3	<3	<3	<3	<3
Sr	1000	1500	1000	2000	2500	1000	2000
Ti							
V	15	<10	20	<10	<10	<10	<10
Y	<10	<10	<10	<10	<10	<10	<10
Zn	70	60	110	110	80	55	205
Zr	250	80	300	250	250	250	200
La	<100	<100	<100	<100	<100	<100	<100
Nd	<100	<100	<100	<100	<100	<100	<100
Ce	320	250	160	770	180	210	70

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
889	LR 23-17	853	LW 22-9
891	LR 23-19	849	LW 22-4B
850	LW 22-5	863	LW 22-20
852	LW 22-8		

TABLE A-3 continued.

	UNIT 5A			UNIT 5B			
Ref. No.	872	911	914	890	892	881	910
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	3240	8000	880	1600	1700	980	1600
Be	10	6	4	6	8	10	10
Bi							
Co	10	9	6	8	15	20	6
Cr	15	<5	9	15	40	40	7
Cu	9	15	15	8	20	40	8
Ga	9	8	15	9	10	8	15
Hg							
Li	10	10	3	7	120	20	10
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	600	250	80	200	200	350	200
Ni	<5	<5	<5	<5	15	30	<5
Pb	15	<10	<10	15	15	10	10
Rb	100	290	170	150	110	140	200
Sb							
Sc	<5	5	<5	<5	<5	10	<5
Sn	<5	<3	<3	<3	<3	<3	<3
Sr	4500	6000	800	1000	2500	2000	1000
Ti							
V	20	15	10	15	45	100	25
Y	45	35	<10	<10	45	50	10
Zn	240	100	55	65	145	175	135
Zr	450	250	200	250	250	300	300
La	<100	150	<100	<100	<300	300	<100
Nd	<100	<100	<100	<100	<200	250	<100
Ce	580	440	110	350	640	490	180

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
872	LW 23-1	892	LR 23-20
911	LW 30-20A	881	LW 23-10
914	LW 30-22	910	LW 30-18B
890	LR 23-18		

TABLE A-3 continued.

	UNIT 5B				UNIT 5C		
Ref. No.	**912**	**913**	**945**	**951**	**845**	**846**	**882**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	470	1630	6700	1500	1840	2080	5250
Be	6	10	4	8	4	5	7
Bi							
Co	<5	8	20	35	5	5	10
Cr	<5	<5	20	440	<5	<5	<5
Cu	8	8	25	80	6	<5	10
Ga	9	9	9	9	8	8	10
Hg							
Li	10	10	4	35	6	6	15
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	150	350	100	800	250	60	500
Ni	<5	<5	6	115	<5	<5	<5
Pb	10	15	10	50	10	15	35
Rb	190	140	100	230	120	110	150
Sb							
Sc	<5	<5	<5	10	<5	<5	<5
Sn	<3	<3	<3	4	<3	<3	<3
Sr	1000	1500	7000	4000	3000	4000	3000
Ti							
V	<10	<10	70	90	<10	<10	<10
Y	20	25	20	30	<10	<10	45
Zn	95	130	195	190	45	50	105
Zr	300	300	200	200	150	150	250
La	100	<100	350	<100	<100	<100	250
Nd	<100	<100	200	<100	<100	<100	250
Ce	230	200	900	270	80	140	740

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
912	LW 30-20B	845	LW 12-1
913	LW 30-21	846	LW 12-2
945	L10 40.6-41.0	882	LR 23-10
951	L12 78.2-78.5		

TABLE A-3 continued.

	UNIT 5C						
Ref. No.	858	859	860	870	870*	873	874
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	4600	2080	8000	3920	2780	1620	3420
Be	9	5	7	10	10	8	10
Bi							
Co	8	5	15	6	<5	15	<5
Cr	<5	<5	5	6	10	20	10
Cu	10	<5	15	15	9	9	9
Ga	9	8	8	15	9	9	9
Hg							
Li	10	6	15	10	8	15	25
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	300	<30	200	150	<30	150	200
Ni	<5	<5	<5	<5	<5	10	<5
Pb	30	10	15	<10	10	10	25
Rb	150	110	170	80	170	120	160
Sb							
Sc	<5	<5	<5	<5	<5	6	<5
Sn	<3	<3	<3	5	<3	<5	<5
Sr	4000	2500	5000	4500	2000	3500	4000
Ti							
V	<10	<10	25	<10	<10	60	30
Y	<10	<10	<10	<10	<10	45	30
Zn	90	40	105	195	75	175	120
Zr	200	80	250	250	100	250	200
La	<100	<100	<100	<100	<100	200	300
Nd	<100	<100	<100	<100	<100	<100	<100
Ce	420	420	340	150	220	530	310

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

* Duplicate sample

Reference No.	Sample No.	Reference No.	Sample No.
858	LW 22-15	870*	LW 22-31B
859	LW 22-16	873	LW 23-2
860	LW 22-16A	874	LW 23-3
870	LW 22-31A		

TABLE A-3 continued.

	UNIT 5C						
Ref. No.	**875**	**894**	**895**	**896**	**898**	**902**	**916**
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	2340	2340	1480	3000	4000	2280	2100
Be	15	8	8	8	8	8	4
Bi							
Co	20	<5	<5	<5	<5	<5	6
Cr	20	<5	7	<5	<5	<5	<5
Cu	30	7	5	15	5	5	9
Ga	8	7	15	9	20	10	7
Hg							
Li	20	8	10	10	15	9	8
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	350	200	200	100	200	350	150
Ni	15	<5	<5	<5	<5	<5	<5
Pb	20	<10	<10	15	25	15	<10
Rb	130	110	120	120	340	120	120
Sb							
Sc	7	<5	<5	<5	<5	<5	<5
Sn	<3	<3	<3	<3	<3	<3	<3
Sr	2500	3000	3000	3000	1000	2000	4000
Ti							
V	90	20	20	25	20	<10	<10
Y	60	<10	<10	<10	<10	<10	25
Zn	220	70	80	75	60	90	65
Zr	500	150	150	200	200	900	150
La	150	300	<100	<100	<100	<100	<100
Nd	250	<100	<100	<100	<100	<100	<100
Ce	690	180	260	210	130	70	300

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
875	LW 23-4	898	LW 30-6
894	LW 30-2	902	LW 30-10A
895	LW 30-3	916	LW 30-25
896	LW 30-4		

TABLE A-3 continued.

	UNIT 5C						
Ref. No.	930	931	938	939	941	942	943
Ag	<1	<1	<1	<1	<1	<1	<1
Au							
As							
Ba	1300	1300	810	2000	1200	1200	1700
Be	5	5	5	7	7	7	9
Bi							
Co	10	8	8	9	9	6	8
Cr	6	<5	5	6	<5	5	5
Cu	5	6	15	7	10	10	20
Ga	7	9	9	9	9	8	10
Hg							
Li	7	6	15	8	8	8	8
Mn							
Mo	<1	<1	<1	<1	<1	<1	<1
Nb	100	150	100	400	150	200	100
Ni	<5	<5	<5	<5	<5	<5	<5
Pb	<10	<10	15	15	20	<10	20
Rb	180	160	290	160	170	190	240
Sb							
Sc	<5	<5	<5	<5	<5	<5	<5
Sn	<3	<3	<3	<3	<3	<3	<3
Sr	1500	1500	900	1500	1500	1500	1500
Ti							
V	15	<10	<10	15	<10	<10	<10
Y	20	<10	<10	<10	<10	<10	<10
Zn	80	60	55	80	70	60	85
Zr	200	150	80	250	150	200	150
La	<100	<100	<100	<100	<100	<100	<100
Nd	<100	<100	<100	<100	<100	<100	<100
Ce	120	30	210	100	156	50	90

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
930	L1 168.1-168.85	941	L5 214.3-214.9
931	L2 79.0-79.8	942	L6 51.3-51.7
938	L2 271.6-272.0	943	L8 169.2-169.75
939	L5 46.5-46.9		

TABLE A-3 continued.

	UNIT 5C		UNIT 6					MISC.
Ref. No.	**950**	**953**	**924**	**925**	**926**	**927**	**928**	**923**
Ag	<1	<1	<1	<1	<1	<1	<1	<1
Au								
As								<1
Ba	1900	2200	360	380	530	590	360	3000
Be	4	4	<1	3	<1	4	7	8
Bi								
Co	9	8	10	7	6	15	10	6
Cr	5	5	<5	5	<5	<5	<5	<10
Cu	6	<5	30	20	25	30	25	3
Ga	7	7	4	3	<1	2	2	10
Hg	8							
Li	6	6	<3	<3	3	5	3	<20
Mn								
Mo	<1	<1	<1	<1	<1	<1	50	<10
Nb	250	50	300	700	700	3000	>0.3%	200
Ni	<5	<5	5	<5	<5	<5	<5	5
Pb	<10	<10	45	55	60	65	80	<10
Rb	90	90	<10	<10	<10	<10	10	
Sb								<4
Sc	<5	<5	<5	<5	<5		7	<20
Sn	<3	<3	7	5	<3	15	15	<10
Sr	3000	3000	2.5%	2.9%	3.2%	1.8%	1.8%	500
Ti								
V	<10	<10	100	30	10	100	45	10
Y	<10	<10	200	350	250	300	350	<20
Zn	65	40	205	80	40	205	155	100
Zr	200	60	200	300	200	300	400	250
La	<100	<100	1000	2000	1000	2000	2000	-
Nd	<100	<100	2000	3000	1000	2500	3500	-
Ce	60	<50	1480	1980	1210	1760	2270	-

Notes:
Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.
For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
950	L11 45.7-46.2	926	Lac 3
953	L13 31.2-32.0	927	Lac 4
924	Lac 1	928	Lac 5
925	Lac 2	923	BC13-5B

TABLE A-4. NORMATIVE MINERALS (CIPW NORM) FOR WHOLE-ROCK SAMPLES FROM THE LACKNER LAKE ALKALIC ROCK COMPLEX

	UNIT 3A						
Ref. No.	897	899	901	903	904	905	906
S.G.	2.99	3.01	3.00	3.02	2.92	2.95	2.99
AP	0.12	1.15	0.17	0.66	0.96	0.09	0.09
PO	0.03	0.03	0.03	0.03	0.03	0.03	0.03
IL	0.25	0.17	0.33	0.21	0.23	0.23	0.40
OR	0.0	0.0	0.0	0.0	10.22	0.0	0.0
AB	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	9.82	8.02	8.43	7.18	7.99	9.28	14.12
MT	0.0	0.24	0.59	0.16	0.56	0.0	0.10
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.37	0.0	0.05	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	11.21	12.82	14.59	14.17	10.43	8.93	12.66
FO	1.55	1.51	0.81	1.42	0.0	1.96	1.75
FA	2.81	2.62	1.52	2.59	0.0	3.52	2.43
NE	36.17	36.37	35.49	33.79	31.09	40.22	38.45
LC	17.10	15.40	13.75	15.91	16.99	17.87	12.58
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	16.43	17.64	21.66	20.45	21.45	12.67	13.94
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.30	0.0	0.0	0.0	0.0	0.07	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	4.16	4.05	2.27	3.43	0.0	5.12	3.45

S.G. - Specific Gravity; AP - Apatite; PO - Pyrrhotite; IL - Ilmenite;
OR - Orthoclase; AB - Albite; AN - Anorthite; C - Corundum;
AC - Acmite; MT - Magnetite; HM - Hematite; WO - Wollastonite;
EN - Enstatite; FS - Ferrosilite; Q - Quartz; DI - Diopside;
FO - Forsterite; FA - Fayalite; NE - Nepheline; LC - Leucite;
KP - Kaliophilite; HE - Hedenbergite; CC - Calcite; RU - Rutile;
NS - Na_2SiO_3; KS - Kalsilite; CR - Chromite; LN - Larnite
Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
897	LW 30-5	904	LW 30-12
899	LW 30-8	905	LW 30-13
901	LW 30-9	906	LW 30-14
903	LW 30-10B		

TABLE A-4 continued.

	UNIT 3A						UNIT 4A
Ref. No.	**917**	**918**	**919**	**920**	**921**	**922**	**885**
S.G.	3.03	2.99	3.03	3.05	2.98	3.60	3.18
AP	0.07	0.09	0.12	0.09	0.12	0.47	6.20
PO	0.03	0.03	0.03	0.03	0.03	0.03	0.03
IL	0.29	0.35	0.37	1.52	0.23	7.50	2.89
OR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AB	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0	2.99	0.50
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	9.58	6.90	11.70	9.23	8.46	0.0	0.0
MT	0.18	0.67	0.31	3.44	0.62	34.83	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	9.32
WO	0.0	0.0	0.0	0.0	0.14	0.0	4.54
EN	0.0	0.0	0.0	0.0	0.0	0.0	7.43
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	13.99	14.60	14.97	8.18	11.69	9.49	22.60
FO	1.95	1.55	1.04	2.14	1.56	0.88	2.68
FA	2.95	2.39	1.69	3.97	2.58	2.06	0.0
NE	35.78	37.29	37.10	37.36	38.48	16.37	24.74
LC	14.07	15.97	11.45	16.48	16.71	6.75	15.80
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	16.78	17.85	19.33	12.01	15.29	17.64	0.0
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	4.34	2.33	1.91	5.55	4.09	0.99	3.28

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
917	LW 30-28	921	LW 30-36
918	LW 30-30	922	BC 13-1C
919	LW 30-33	885	LR 23-13
920	LW 30-34		

TABLE A-4 continued.

	UNIT 4A						
Ref. No.	847	848	854	855	857	861	865
S.G.	3.15	3.05	2.70	2.73	2.91	2.72	3.08
AP	6.38	4.15	0.37	0.28	1.49	0.31	4.25
PO	0.03	0.03	0.14	0.06	0.11	0.03	0.06
IL	2.85	2.25	0.59	0.48	2.19	0.37	2.82
OR	0.0	3.69	45.19	43.55	32.31	43.36	4.39
AB	0.0	0.0	2.82	10.09	7.69	12.94	0.0
AN	5.05	0.16	0.0	3.40	3.63	0.41	3.85
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	2.08	0.0	0.0	0.0	0.0
MT	11.56	8.44	3.53	4.49	5.11	4.95	11.72
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.25	0.0	0.0	0.29	1.61
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	24.78	22.64	3.23	1.05	6.83	2.94	21.77
FO	3.30	2.96	0.0	0.23	1.41	0.0	0.0
FA	0.72	1.28	0.0	1.83	3.28	0.0	0.0
NE	20.79	30.21	37.35	27.86	23.35	26.86	21.36
LC	16.37	16.47	0.0	0.0	0.0	0.0	17.15
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	4.26	7.73	4.45	6.68	12.60	7.56	11.04
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	3.91	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
847	LW 22-1	857	LW 22-13
848	LW 22-2	861	LW 22-18
854	LW 22-10	865	LW 22-22A
855	LW 22-11		

TABLE A-4 continued.

	UNIT 4A						
Ref. No.	**864**	**867**	**869**	**907**	**909**	**929**	**933**
S.G.	2.74	3.04	2.86	3.00	3.03	3.00	2.94
AP	0.35	2.88	0.40	1.11	0.07	0.05	1.96
PO	0.06	0.03	0.03	0.08	0.03	0.03	0.03
IL	0.41	2.16	0.33	0.25	0.33	0.15	0.12
OR	42.61	0.0	41.00	0.0	0.0	0.0	0.0
AB	3.76	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	3.13	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	2.49	0.0	1.91	11.05	8.15	6.70	6.28
MT	3.17	5.42	1.49	0.84	0.83	0.91	1.03
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.50	0.0	0.0	0.11	0.0	0.19	1.20
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	3.00	18.30	3.58	11.49	18.40	11.15	8.36
FO	0.0	6.61	0.02	1.50	0.82	1.91	3.15
FA	0.0	3.32	0.05	2.35	1.22	3.60	4.31
NE	35.87	27.23	42.58	33.62	35.10	36.64	39.31
LC	0.0	19.17	0.55	14.55	12.34	16.71	17.68
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	7.81	7.27	8.06	14.26	21.59	16.59	9.05
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	4.49	0.0	3.81	1.13	5.38	7.51

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
864	LW 22-22B	909	LW 30-18A
867	LW 22-25	929	L1 139.0-139.2
869	LW 22-29	933	L2 136.8-137.2
907	LW 30-16		

TABLE A-4 continued.

	UNIT 4A						
Ref. No.	934	935	936	937	940	944	946
S.G.	3.13	3.18	3.16	3.17	3.18	3.10	3.02
AP	3.99	2.27	0.80	1.40	4.88	4.86	2.53
PO	0.06	0.03	0.0	0.03	0.14	0.03	0.03
IL	0.21	1.17	0.95	1.11	2.62	0.20	1.80
OR	0.0	0.0	14.57	0.0	0.0	0.0	4.39
AB	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AN	0.0	0.0	0.0	0.0	0.0	0.0	1.23
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	4.50	7.93	7.47	7.03	5.69	4.14	0.0
MT	1.74	4.87	10.32	5.40	9.83	2.36	10.26
HM	0.0	0.0	2.76	0.0	0.0	0.0	0.0
WO	0.94	0.10	13.76	0.48	0.0	6.93	3.47
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	19.54	15.59	21.15	17.36	14.00	11.51	19.07
FO	1.44	1.66	0.0	1.22	6.33	1.79	0.0
FA	2.03	2.81	0.0	1.95	2.73	3.68	0.0
NE	28.05	26.76	27.72	27.04	24.73	28.21	31.04
LC	12.20	11.53	0.51	11.82	15.32	12.26	20.07
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	21.83	20.88	0.0	22.01	4.77	18.72	6.11
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	3.48	4.41	0.0	3.14	8.98	5.31	0.0

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
934	L2 150.65-151.0	940	L5 91.1-91.3
935	L2 218.6-218.8	944	L9 111.3-111.65
936	L2 223.6-223.8	946	L10 166.9-167.2
937	L2 243.3-243.6		

TABLE A-4 continued.

	UNIT 4A				UNIT 4B		
Ref. No.	947	948	949	952	932	856	862
S.G.	3.02	3.01	2.99	3.20	2.71	2.76	2.76
AP	2.65	2.69	2.81	2.89	2.08	0.38	0.26
PO	0.03	0.03	0.03	0.34	0.03	0.11	0.08
IL	1.74	1.66	1.68	3.16	0.18	0.56	0.44
OR	0.13	1.41	11.01	0.0	51.83	40.97	42.14
AB	0.0	0.0	0.0	0.0	0.0	10.09	11.81
AN	0.0	0.02	0.85	12.76	0.0	0.0	0.42
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.51	0.0	0.0	0.0	1.10	2.24	0.0
MT	10.62	9.68	11.36	4.96	1.32	5.87	5.39
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	4.60	5.25	5.14	0.0	0.0	0.38	0.46
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	19.18	18.20	18.64	21.30	6.98	3.51	3.16
FO	0.0	0.0	0.0	11.62	0.02	0.0	0.0
FA	0.0	0.0	0.0	4.10	0.03	0.0	0.0
NE	33.68	33.99	30.59	12.39	24.17	26.49	27.09
LC	21.00	20.98	15.90	10.03	3.11	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	5.86	6.11	1.99	5.94	9.16	9.39	8.74
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	10.51	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
947	L10 202.7-203.0	932	L2 117.65
948	L10 225.6-225.9	856	LW 22-12A
949	L10 236.6-236.95	862	LW 22-19
952	L12 476.7-477.1		

TABLE A-4 continued.

	UNIT 4B			UNIT 4C				
Ref. No.	866	868	908	879	883	886	887	893
S.G.	2.79	2.74	2.85	2.82	2.78	3.04	2.75	2.83
AP	0.47	0.38	0.35	0.36	0.31	3.09	0.47	1.09
PO	0.06	0.06	0.11	0.03	0.06	0.03	0.19	0.03
IL	0.59	0.58	0.70	1.31	0.52	2.10	0.37	1.18
OR	40.52	44.50	41.46	43.08	41.81	1.09	42.78	32.35
AB	10.31	9.46	5.35	32.48	7.13	0.0	4.82	0.0
AN	0.0	0.0	0.0	1.91	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	2.49	0.70	3.03	0.0	4.01	0.77	4.30	1.35
MT	5.90	4.45	6.06	2.93	3.81	10.21	2.35	2.94
HM	0.0	0.0	0.0	10.87	0.0	0.0	0.0	0.0
WO	1.69	1.03	0.0	0.74	0.72	5.35	0.23	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	3.62	3.00	4.59	3.20	3.38	25.39	3.26	7.45
FO	0.0	0.0	0.14	0.0	0.0	0.0	0.0	0.95
FA	0.0	0.0	0.49	0.0	0.0	0.0	0.0	1.90
NE	26.35	28.46	25.26	3.08	29.98	35.57	31.92	38.30
LC	0.0	0.0	0.0	0.0	0.0	13.42	0.0	0.73
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	8.00	7.39	12.45	0.0	8.28	2.98	9.31	11.74
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
866	LW 22-23	883	LR 23-11
868	LW 22-26	886	LR 23-14
908	LW 30-17	887	LR 23-15
879	LW 23-7	893	LR 23-23

TABLE A-4 continued.

	UNIT 4C					UNIT 5A		
Ref. No.	**851**	**876**	**877**	**880**	**915**	**884**	**884***	**888**
S.G.	2.74	2.76	2.76	3.01	2.84	2.76	2.76	2.71
AP	0.52	0.38	0.38	2.12	0.98	0.49	0.52	0.41
PO	0.14	0.08	0.06	0.06	0.03	0.06	0.03	0.03
IL	0.56	0.46	0.40	1.93	0.75	0.56	0.56	0.53
OR	41.68	41.70	42.88	23.46	42.79	41.93	42.55	47.80
AB	0.04	7.09	0.63	0.0	5.60	4.21	5.32	13.53
AN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.89
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.15
AC	3.24	4.05	5.45	1.82	5.12	4.40	3.15	0.0
MT	2.67	3.96	1.99	4.96	3.36	3.04	4.02	4.27
HM	0.0	0.0	0.0	0.0	5.53	0.0	0.0	0.0
WO	0.0	0.58	0.0	0.0	6.03	0.0	0.72	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	3.76	2.78	2.83	14.17	5.16	3.30	3.27	0.0
FO	0.08	0.0	0.03	0.80	0.0	0.02	0.0	1.77
FA	0.23	0.0	0.17	1.39	0.0	0.07	0.0	2.41
NE	38.92	30.35	34.12	28.42	24.66	32.59	32.15	15.21
LC	0.0	0.0	0.0	1.37	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	8.15	8.56	11.07	19.52	0.0	9.32	7.73	0.0
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

* Duplicate sample

Reference No.	Sample No.	Reference No.	Sample No.
851	LW 22-7	915	LW 30-23
876	LW 23-5	884	LR 23-12A
877	LW 23-6	884*	LR 23-12B
880	LW 23-9	888	LR 23-16

TABLE A-4 continued.

	UNIT 5A						
Ref. No.	889	891	850	852	853	849	863
S.G.	2.73	2.68	2.76	2.72	2.71	2.75	2.71
AP	0.49	0.24	0.43	0.38	0.43	0.87	0.31
PO	0.11	0.06	0.14	0.14	0.14	0.08	0.03
IL	0.48	0.68	0.85	0.57	0.49	0.44	0.27
OR	40.96	45.58	37.91	40.49	41.76	42.24	46.17
AB	3.61	9.86	10.07	4.21	3.22	9.05	26.00
AN	0.0	0.76	1.75	0.0	0.0	0.0	1.11
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	2.48	0.0	0.0	2.65	2.52	1.43	0.0
MT	3.18	3.19	5.64	3.54	3.08	5.26	9.16
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.15
WO	0.0	0.0	0.0	0.0	0.72	0.42	0.62
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	3.57	2.04	4.21	3.24	2.76	2.82	0.66
FO	0.03	0.03	0.04	0.39	0.0	0.0	0.0
FA	0.07	0.08	0.07	0.94	0.0	0.0	0.0
NE	37.60	33.11	32.46	37.27	38.99	29.27	15.52
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	7.41	4.38	6.43	6.17	5.90	8.14	0.0
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
889	LR 23-17	853	LW 22-9
891	LR 23-19	849	LW 22-4B
850	LW 22-5	863	LW 22-20
852	LW 22-8		

TABLE A-4 continued.

	UNIT 5A			UNIT 5B			
Ref. No.	872	911	914	890	892	881	910
S.G.	2.86	2.79	2.76	2.71	2.84	2.91	2.76
AP	1.40	1.22	0.39	0.40	1.28	1.60	0.12
PO	0.03	0.06	0.11	0.03	0.06	0.14	0.11
IL	1.98	1.75	0.34	0.41	1.15	1.68	0.70
OR	32.93	47.84	42.49	44.61	33.09	15.03	29.90
AB	7.35	5.08	7.86	23.91	6.18	0.0	0.0
AN	2.86	7.73	0.0	12.27	15.82	0.20	0.0
C	0.0	0.0	0.0	4.00	0.0	0.0	1.46
AC	0.0	0.0	2.55	0.0	0.0	0.0	2.41
MT	4.55	3.16	3.33	3.42	3.78	3.51	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.20	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	4.54	3.51	2.67	0.0	6.00	13.83	4.63
FO	1.66	1.58	0.0	1.04	2.17	1.62	0.82
FA	4.90	2.65	0.0	2.72	4.00	2.21	2.09
NE	27.25	20.78	29.15	7.17	17.70	34.09	41.68
LC	0.0	0.0	0.0	0.0	0.0	11.22	6.69
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	10.57	4.66	10.91	0.0	8.76	14.87	9.38
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
872	LW 23-1	892	LR 23-20
911	LW 30-20A	881	LW 23-10
914	LW 30-22	910	LW 30-18B
890	LR 23-18		

TABLE A-4 continued.

	UNIT 5B				UNIT 5C		
Ref. No.	912	913	945	951	845	846	882
S.G.	2.67	2.70	2.98	3.03	2.62	2.61	2.73
AP	0.33	0.42	0.92	0.10	0.21	0.26	0.96
PO	0.06	0.03	0.14	0.92	0.03	0.03	0.09
IL	0.70	0.75	2.14	1.54	0.37	0.25	1.30
OR	45.56	41.47	40.51	9.26	46.16	44.16	38.97
AB	10.41	5.60	3.28	0.0	8.82	6.65	0.33
AN	3.01	2.26	5.98	16.95	0.99	2.65	3.11
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.01	2.75	14.31	8.23	1.72	2.45	2.79
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.74	0.0	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	0.68	1.69	9.13	28.72	0.54	0.17	3.15
FO	0.49	0.71	0.0	0.07	0.15	0.23	0.82
FA	2.90	2.70	0.0	0.03	0.74	1.02	1.75
NE	30.69	36.54	16.66	5.53	38.11	41.54	41.42
LC	0.0	0.0	0.0	19.61	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	3.18	5.09	6.20	9.04	2.17	0.59	5.31
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
912	LW 30-20B	845	LW 12-1
913	LW 30-21	846	LW 12-2
945	L10 40.6-41.0	882	LR 23-10
951	L12 78.2-78.5		

TABLE A-4 continued.

	UNIT 5C						
Ref. No.	**858**	**859**	**860**	**870**	**870***	**873**	**874**
S.G.	2.72	2.61	2.78	2.70	2.66	2.92	2.69
AP	0.67	0.19	0.85	0.73	0.40	1.64	0.45
PO	0.06	0.03	0.12	0.08	0.06	0.06	0.03
IL	1.10	0.27	1.49	0.64	0.27	1.64	0.94
OR	40.10	44.32	42.99	17.58	43.12	24.22	43.67
AB	3.17	7.80	12.74	22.37	8.14	0.0	0.0
AN	4.67	0.60	8.36	0.0	1.62	0.0	0.10
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	11.49	0.0	0.27	0.0
MT	1.49	2.22	2.77	6.99	1.99	4.99	2.71
HM	0.0	0.0	0.0	0.38	0.0	0.0	0.0
WO	0.0	0.0	0.0	3.71	0.0	0.0	0.0
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	1.79	0.28	3.01	4.37	1.97	11.85	2.66
FO	1.09	0.09	1.61	0.0	0.17	0.73	0.60
FA	2.83	0.74	3.64	0.0	0.43	1.26	1.08
NE	39.36	41.56	17.03	31.66	37.86	32.83	43.94
LC	0.0	0.0	0.0	0.0	0.0	4.26	0.04
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	3.68	1.89	5.39	0.0	3.99	16.25	3.80
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

* Duplicate sample

Reference No.	Sample No.	Reference No.	Sample No.
858	LW 22-15	870*	LW 22-31B
859	LW 22-16	873	LW 23-2
860	LW 22-16A	874	LW 23-3
870	LW 22-31A		

TABLE A-4 continued.

	UNIT 5C						
Ref. No.	**875**	**894**	**895**	**896**	**898**	**902**	**916**
S.G.	2.98	2.66	2.68	2.65	2.59	2.64	2.72
AP	1.98	0.26	1.22	0.24	0.26	0.26	0.52
PO	0.06	0.06	0.03	0.09	0.06	0.06	0.06
IL	2.09	0.54	0.51	0.49	0.43	0.55	1.20
OR	25.23	38.37	11.93	29.87	61.33	44.90	39.55
AB	0.0	0.0	0.0	0.0	15.66	3.95	7.15
AN	0.0	0.0	0.0	0.0	2.32	0.0	0.0
C	0.0	0.0	0.0	0.0	0.31	0.0	0.0
AC	1.15	3.83	3.94	4.20	0.0	0.97	0.73
MT	4.20	0.92	0.0	0.64	1.01	2.59	3.97
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.0	0.0	0.28	0.70	0.0	0.0	1.31
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	12.44	2.22	3.32	1.72	0.0	1.51	2.91
FO	1.32	0.06	0.0	0.0	0.74	0.08	0.0
FA	2.56	0.18	0.0	0.0	1.11	0.19	0.0
NE	28.41	45.76	49.18	45.66	16.78	42.12	37.76
LC	1.51	2.58	21.92	11.57	0.0	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	19.04	5.24	6.89	4.84	0.0	2.83	4.86
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.78	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
875	LW 23-4	898	LW 30-6
894	LW 30-2	902	LW 30-10A
895	LW 30-3	916	LW 30-25
896	LW 30-4		

TABLE A-4 continued.

	UNIT 5C						
Ref. No.	**930**	**931**	**938**	**939**	**941**	**942**	**943**
S.G.	2.75	2.69	2.61	2.69	2.68	2.66	2.67
AP	0.93	0.21	0.50	0.07	0.31	0.07	0.14
PO	0.03	0.06	0.14	0.06	0.06	0.09	0.14
IL	0.45	0.54	0.33	0.60	0.51	0.27	0.35
OR	36.11	47.93	32.31	40.59	45.57	51.32	50.72
AB	0.0	1.90	0.0	0.0	0.0	2.70	3.04
AN	0.0	0.73	0.12	0.0	0.0	0.0	0.20
C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.56	0.0	0.0	4.83	2.99	0.61	0.0
MT	2.76	3.45	0.67	1.11	2.05	2.12	2.55
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WO	0.76	0.51	0.0	0.27	0.87	0.79	0.12
EN	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Q	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DI	5.19	2.12	1.00	2.26	1.76	1.55	1.53
FO	0.0	0.0	0.20	0.0	0.0	0.0	0.0
FA	0.0	0.0	0.86	0.0	0.0	0.0	0.0
NE	31.87	36.90	35.67	36.73	36.88	34.67	33.93
LC	10.01	0.0	24.78	5.54	2.14	0.0	0.0
KP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE	11.33	5.66	3.42	7.95	6.79	5.81	7.29
CC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LN	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.	Reference No.	Sample No.
930	L1 168.1-168.85	941	L5 214.3-214.9
931	L2 79.0-79.8	942	L6 51.3-51.7
938	L2 271.6-272.0	943	L8 169.2-169.75
939	L5 46.5-46.7		

TABLE A-4 continued.

	UNIT 5C		MISC.
Ref. No.	950	953	923
S.G.	2.68	2.62	2.68
AP	0.28	0.17	0.05
PO	0.03	0.03	0.03
IL	0.35	0.23	0.32
OR	42.99	47.57	51.54
AB	0.0	2.80	10.44
AN	0.38	0.0	7.63
C	0.0	0.0	0.0
AC	0.0	0.48	0.0
MT	2.74	0.76	2.53
HM	0.0	0.0	0.0
WO	0.0	0.0	0.0
EN	0.0	0.0	0.0
FS	0.0	0.0	0.0
Q	0.0	0.0	0.0
DI	1.22	0.49	2.24
FO	0.05	0.06	0.75
FA	0.32	0.54	1.07
NE	45.08	43.25	20.87
LC	0.17	0.0	0.0
KP	0.0	0.0	0.0
HE	6.40	3.64	2.53
CC	0.0	0.0	0.0
RU	0.0	0.0	0.0
NS	0.0	0.0	0.0
KS	0.0	0.0	0.0
CR	0.0	0.0	0.0
LN	0.0	0.0	0.0

Note: For sample descriptions, see Table A-1.

Reference No.	Sample No.
950	L11 45.7-46.2
953	L13 31.2-32.0
923	BC13-5B

TABLE A-5. NORMATIVE MINERALS (ALKALIC ROCKS) FOR WHOLE-ROCK SAMPLES FROM THE LACKNER LAKE ALKALIC ROCK COMPLEX.

	UNIT 3A						
Ref. No.	897	899	901	903	904	905	906
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR	0.18	0.0	0.0	0.36	14.26	0.0	0.0
AB	5.69	4.82	8.20	6.06	7.92	4.52	6.03
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	45.14	40.79	35.96	41.40	36.50	47.49	33.35
CAR	0.0	3.67	4.03	0.0	0.0	2.89	10.53
NS	0.22	0.0	0.0	0.0	0.0	0.0	0.0
AC	9.78	7.65	7.95	6.82	7.64	9.21	12.23
TH	0.09	0.09	0.09	0.09	0.09	0.09	0.09
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	17.91	19.36	18.55	20.17	14.51	16.42	16.44
D.EN	6.70	7.48	6.78	7.60	4.34	6.25	7.08
D.FS	11.54	12.16	12.16	12.92	10.78	10.44	9.36
FO	0.45	0.36	0.66	0.62	0.31	0.43	0.83
FA	0.86	0.64	1.30	1.16	0.86	0.80	1.20
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.27	0.50	0.21	0.49	0.01	0.68
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SPH	0.32	0.22	0.42	0.69	0.29	0.29	0.52
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AP	0.12	1.16	0.17	0.66	0.97	0.09	0.09
CC	0.95	0.77	1.82	0.86	0.77	0.77	0.91
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.45	0.34	0.35	0.22	0.31	0.27	0.44
SUM	100.39	99.77	98.94	99.83	100.04	99.99	99.80

QZ - Quartz; CO - Corundum; OR - Orthoclase; AB - Albite; LC - Leucite; KAL - Kalsilite; NEPH - Nepheline; CAR - Carnegieite; NS - Na_2SiO_3; AC - Acmite; TH - Thenardite; GEH - Gehlenite; AKM - Akermanite; FE-AK - Fe-Akermanite; D.WO - Wollastonite; D.EN - Enstatite; D.FS - Ferrosilite; FO - Forsterite; FA - Fayalite; ANDR - Andradite; HM - Hematite; MT - Magnetite; SPH - Sphene; PERV - Perovskite; RU - Rutile; AP - Apatite; CC - Calcite; MGS - Magnesite; FL - Fluorite; ZR - Zircon; BAD - Baddeleyite

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
897	LW 30-5	904	LW 30-12
899	LW 30-8	905	LW 30-13
901	LW 30-9	906	LW 30-14
903	LW 30-10B		

TABLE A-5 continued.

	UNIT 3A						UNIT 4A
Ref. No.	917	918	919	920	921	922	885
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR	0.0	0.0	0.0	0.0	0.0	0.34	0.0
AB	6.62	7.61	5.58	2.22	5.99	6.60	0.0
LC	0.0	0.0	0.0	0.0	0.0	0.0	2.19
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.69
NEPH	37.32	42.16	30.25	43.40	44.39	17.02	32.99
CAR	4.68	1.95	11.56	3.94	2.60	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	9.21	6.52	11.27	8.80	8.11	0.0	0.0
TH	0.09	0.09	0.09	0.09	0.09	0.04	0.09
GEH	0.0	0.0	0.0	0.0	0.0	2.98	0.66
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	18.40	17.91	18.27	15.21	17.50	7.00	19.59
D.EN	7.93	7.26	7.24	4.95	6.85	1.72	12.29
D.FS	10.47	10.80	11.23	10.78	10.86	5.69	6.06
FO	0.86	1.10	0.73	1.24	0.50	2.67	1.17
FA	1.25	1.81	1.25	2.98	0.87	9.74	0.64
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.23	0.56	0.31	2.44	0.53	0.0	10.72
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SPH	0.37	0.44	0.47	1.94	0.29	34.28	3.66
PERV	0.0	0.0	0.0	0.0	0.0	9.52	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AP	0.78	0.09	0.12	0.09	0.12	0.0	6.20
CC	1.36	0.77	0.73	0.73	1.09	0.47	1.18
MGS	0.0	0.0	0.0	0.0	0.0	0.41	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.32	0.30	0.41	0.33	0.29	0.33	0.59
SUM	99.89	99.37	99.52	99.14	100.09	98.81	98.72

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
917	LW 30-28	921	LW 30-36
918	LW 30-30	922	BC 13-1C
919	LW 30-33	885	LR 23-13
920	LW 30-34		

TABLE A-5 continued.

	UNIT 4A						
Ref. No.	**847**	**848**	**854**	**855**	**857**	**861**	**865**
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR	7.58	7.09	27.84	31.17	22.70	30.30	15.39
AB	1.60	6.17	23.05	27.03	22.91	26.23	9.73
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	26.74	35.44	36.11	24.16	18.76	26.12	19.99
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.32	0.0	0.0	0.0	0.0
TH	0.09	0.09	0.53	0.22	0.44	0.09	0.22
GEH	5.02	0.33	0.0	3.73	4.37	0.59	4.04
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	14.80	12.43	2.39	0.59	4.83	4.08	9.15
D.EN	8.09	6.50	0.86	0.07	1.43	0.97	4.32
D.FS	6.17	5.57	1.58	0.58	3.61	3.36	4.71
FO	5.35	5.44	0.44	0.50	2.54	0.26	3.66
FA	4.50	5.15	0.88	4.43	7.09	0.99	4.41
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	7.78	5.67	0.17	0.0	0.0	0.37	2.93
MT	0.0	0.0	4.17	4.42	5.03	4.35	6.90
SPH	3.58	2.82	0.76	0.61	2.77	0.32	3.46
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AP	6.34	4.12	0.38	0.28	1.49	0.31	4.12
CC	0.77	0.86	1.05	0.77	0.59	0.64	3.82
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.88	1.17	0.56	0.57	0.73	0.45	0.51
SUM	97.75	98.85	101.09	99.15	99.30	99.42	97.37

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
847	LW 22-1	857	LW 22-13
848	LW 22-2	861	LW 22-18
854	LW 22-10	865	LW 22-22A
855	LW 22-11		

TABLE A-5 continued.

	UNIT 4A						
Ref. No.	864	867	869	907	909	929	933
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR	24.85	7.61	20.91	0.0	0.0	0.0	0.0
AB	21.74	3.04	20.92	5.02	7.39	2.87	1.19
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	35.84	33.62	41.51	38.31	32.61	44.51	46.37
CAR	0.0	0.0	0.0	7.32	6.89	2.50	4.11
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.80	0.0	1.55	9.87	7.76	6.33	5.82
TH	0.22	0.09	0.09	0.31	0.09	0.09	0.09
GEH	0.0	3.16	0.0	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	4.63	13.68	3.99	16.81	19.98	20.35	18.02
D.EN	1.02	7.56	1.11	6.69	8.25	7.42	7.73
D.FS	3.93	5.59	3.08	10.30	11.84	13.36	10.31
FO	0.24	6.79	0.37	0.44	0.91	0.30	0.32
FA	1.04	5.54	1.13	0.75	1.44	0.59	0.47
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	1.47	3.63	0.07	0.92	0.67	0.74	0.82
MT	1.82	0.0	1.52	0.0	0.0	0.0	0.0
SPH	0.52	2.70	0.42	0.32	0.42	0.20	0.15
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AP	0.36	2.84	0.40	1.11	0.07	0.05	1.96
CC	0.64	1.68	1.14	0.68	0.86	0.50	1.34
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.26	0.80	0.68	0.31	0.41	0.26	0.63
SUM	99.36	98.32	98.88	99.22	99.59	100.06	99.34

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
864	LW 22-22B	909	LW 30-18A
867	LW 22-25	929	L1 139.0-139.2
869	LW 22-29	933	L2 136.8-137.2
907	LW 30-16		

TABLE A-5 continued.

	UNIT 4A						
Ref. No.	**934**	**935**	**936**	**937**	**940**	**944**	**946**
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR	0.0	0.0	0.0	0.0	0.0	0.0	11.17
AB	2.82	0.0	7.33	1.87	0.0	0.0	4.46
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	1.87	0.0	0.0
NEPH	31.82	30.63	31.37	31.37	32.64	31.74	38.15
CAR	2.57	4.20	0.33	3.01	0.0	4.22	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	3.74	7.68	7.42	6.55	3.89	3.63	0.0
TH	0.22	0.09	0.0	0.09	0.53	0.09	0.09
GEH	0.0	0.0	0.0	0.0	0.0	0.0	1.24
AKM	0.0	0.0	0.0	0.0	1.78	0.06	0.0
FE-AK	0.0	0.0	0.0	0.0	1.38	0.10	0.0
D.WO	24.88	22.76	16.93	22.70	16.08	22.72	12.97
D.EN	10.41	7.94	9.60	8.07	8.18	7.57	5.82
D.FS	14.58	15.42	6.59	15.17	7.49	15.69	7.08
FO	0.29	1.09	0.0	1.12	4.27	0.01	1.97
FA	0.44	2.35	0.0	2.33	4.32	0.03	2.64
ANDR	0.0	0.0	10.03	0.0	0.0	5.43	0.0
HM	1.39	3.41	6.49	3.85	7.12	0.0	6.95
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SPH	0.27	0.95	1.20	1.42	0.0	0.0	2.28
PERV	0.0	0.38	0.0	0.0	2.26	0.17	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AP	3.98	2.30	0.80	1.42	4.81	4.81	2.53
CC	0.50	0.34	0.0	0.41	0.50	1.09	1.16
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.21	0.18	0.0	0.15	0.24	0.26	0.31
SUM	98.19	99.71	98.12	99.54	97.36	97.63	98.8

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
934	L2 150.65-151.0	940	L5 91.1-91.3
935	L2 218.6-218.8	944	L9 111.3-111.65
936	L2 223.6-223.8	946	L10 166.9-167.2
937	L2 243.3-243.6		

TABLE A-5 continued.

	UNIT 4A				UNIT 4B		
Ref. No.	947	948	949	952	932	856	862
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR	6.29	7.38	13.10	8.73	42.80	28.55	29.37
AB	4.37	4.06	5.39	7.05	11.48	25.23	25.63
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	42.09	42.54	36.96	7.45	23.53	24.22	25.34
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.11	0.0	0.0	0.0	0.87	0.73	0.0
TH	0.09	0.09	0.09	1.33	0.09	0.44	0.31
GEH	0.0	0.02	0.92	14.58	0.0	0.0	1.02
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	14.22	14.66	12.33	13.50	6.02	4.41	4.38
D.EN	6.39	6.57	5.92	8.20	2.19	1.10	1.03
D.FS	7.74	8.01	6.22	4.54	3.96	3.56	3.63
FO	1.60	1.18	1.78	11.97	0.67	0.34	0.29
FA	2.15	1.59	2.06	7.31	1.33	1.21	1.12
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	7.33	6.57	7.71	3.30	0.95	0.0	0.0
MT	0.0	0.0	0.0	0.0	0.0	6.51	5.32
SPH	2.21	2.11	2.13	3.92	0.22	0.71	0.56
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AP	2.65	2.70	2.82	2.84	2.06	0.38	0.26
CC	1.50	1.41	1.50	3.57	1.41	1.45	0.64
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.38	0.31	0.34	0.48	0.68	0.59	0.40
SUM	99.11	99.20	99.28	98.78	98.27	99.42	99.30

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
947	L10 202.7-203.0	932	L2 117.65
948	L10 225.6-225.9	856	LW 22-12A
949	L10 236.6-236.95	862	LW 22-19
952	L12 476.7-477.1		

TABLE A-5 continued.

	UNIT 4B			UNIT 4C				
Ref. No.	**866**	**868**	**908**	**879**	**883**	**886**	**887**	**893**
QZ	0.0	0.0	0.0	1.34	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR	27.39	30.33	29.31	41.08	27.13	0.0	28.45	14.52
AB	22.32	23.09	18.99	36.11	22.07	9.56	24.13	18.21
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	27.01	28.16	23.86	0.0	29.30	37.20	28.89	38.07
CAR	0.0	0.0	0.0	0.0	0.0	2.37	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	1.73	0.0	1.51	0.0	3.20	0.46	1.77	1.01
TH	0.22	0.22	0.44	0.09	0.22	0.09	0.75	0.09
GEH	0.0	0.04	0.0	1.99	0.0	0.0	0.0	0.0
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	6.20	4.74	6.82	0.0	4.86	14.63	3.93	7.75
D.EN	1.27	1.02	1.64	0.0	1.13	7.88	0.99	2.64
D.FS	5.38	4.04	5.59	0.0	4.05	6.24	3.17	5.33
FO	0.28	0.24	0.45	0.99	0.29	2.49	0.35	1.45
FA	1.29	1.04	1.68	0.0	1.15	2.17	1.25	3.23
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	2.95	1.38	0.35	9.02	1.06	6.98	0.0	0.0
MT	1.98	2.73	6.20	4.80	2.59	0.0	3.57	3.05
SPH	0.76	0.74	0.88	1.34	0.66	2.65	0.47	1.50
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.12	0.0	0.0	0.0	0.0
AP	0.47	0.38	0.36	0.36	0.31	3.08	0.47	1.09
CC	0.59	0.68	0.68	0.55	0.91	3.14	1.77	0.59
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.40	0.53	0.25	0.28	0.31	0.47	0.58	0.53
SUM	100.26	99.37	99.01	98.04	99.23	99.40	100.55	99.06

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
866	LW 22-23	883	LR 23-11
868	LW 22-26	886	LR 23-14
908	LW 30-17	887	LR 23-15
879	LW 23-7	893	LR 23-23

TABLE A-5 continued.

	UNIT 4C					UNIT 5A		
Ref. No.	851	876	877	880	915	884	884*	888
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.76
OR	23.01	26.97	26.65	11.15	29.55	26.12	26.48	41.32
AB	20.42	22.56	18.58	13.10	16.18	20.45	20.20	26.58
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	36.96	29.40	32.93	28.66	24.72	32.16	32.40	9.79
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	1.40	2.95	4.65	1.06	4.63	3.61	2.79	0.0
TH	0.53	0.31	0.22	0.22	0.09	0.22	0.09	0.09
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.31
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	4.27	4.63	4.99	14.18	4.89	5.01	5.00	0.0
D.EN	1.21	0.96	0.95	4.67	2.31	1.13	1.11	0.0
D.FS	3.25	4.00	4.43	9.97	2.52	4.21	4.23	0.0
FO	0.42	0.21	0.27	2.02	0.0	0.28	0.27	1.70
FA	1.24	0.98	1.41	4.77	0.0	1.16	1.13	2.70
ANDR	0.0	0.0	0.0	0.0	2.15	0.0	0.0	0.0
HM	0.18	0.68	0.0	3.16	7.05	0.43	1.45	0.0
MT	3.23	3.45	2.35	0.69	0.0	2.77	2.02	4.13
SPH	0.71	0.59	0.52	2.45	0.93	0.71	0.71	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.27
AP	0.52	0.38	0.38	2.13	0.97	0.50	0.52	0.40
CC	0.86	0.86	1.14	0.73	1.36	0.55	0.50	0.59
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.46	0.29	0.50	0.87	0.32	0.34	0.35	2.69
SUM	98.69	99.21	99.96	99.82	97.68	99.65	99.25	99.33

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

* Duplicate sample

Reference No.	Sample No.	Reference No.	Sample No.
851	LW 22-7	915	LW 30-23
876	LW 23-5	884	LR 23-12A
877	LW 23-6	884*	LR 23-12B
880	LW 23-9	888	LR 23-16

TABLE A-5 continued.

	UNIT 5A						
Ref. No.	**889**	**891**	**850**	**852**	**853**	**849**	**863**
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.22
OR	23.11	29.80	22.54	22.63	23.31	28.03	38.36
AB	23.36	26.86	27.09	24.09	24.34	23.69	33.99
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	36.13	31.13	30.64	34.54	36.34	28.78	14.27
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.98	0.0	0.0	0.81	0.70	0.38	0.0
TH	0.44	0.22	0.09	0.53	0.53	0.31	0.09
GEH	0.0	1.18	1.87	0.0	0.0	0.0	0.66
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	3.83	1.00	2.97	2.67	2.62	4.65	0.0
D.EN	1.11	0.26	0.95	0.85	0.77	0.98	0.0
D.FS	2.90	0.80	2.12	1.92	1.96	4.01	0.0
FO	0.39	0.50	0.71	0.79	0.33	0.22	0.21
FA	1.13	1.73	1.74	1.96	0.93	1.00	0.12
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.27	0.0	0.0	0.0	0.0	0.97	0.0
MT	3.48	3.14	5.55	4.31	3.89	4.33	9.21
SPH	0.61	0.83	1.08	0.71	0.61	0.56	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.0	0.0	0.14
AP	0.50	0.24	0.43	0.38	0.43	0.88	0.31
CC	0.95	0.77	0.59	1.18	1.59	0.59	0.73
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.35	0.36	1.00	0.67	0.39	0.37	0.29
SUM	99.56	98.83	99.37	98.07	98.75	99.74	98.59

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
889	LR 23-17	853	LW 22-9
891	LR 23-19	849	LW 22-4B
850	LW 22-5	863	LW 22-20
852	LW 22-8		

TABLE A-5 continued.

	UNIT 5A			UNIT 5B			
Ref. No.	872	911	914	890	892	881	910
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.41	0.0	0.0	0.28	0.0	0.0
OR	20.43	39.29	29.26	22.83	28.62	12.11	17.70
AB	22.88	21.63	24.13	22.35	27.85	12.73	19.21
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	24.66	14.54	28.18	39.71	6.34	35.07	41.55
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	1.09	0.87	0.0	0.0	0.0
TH	0.09	0.22	0.44	0.09	0.22	0.53	0.44
GEH	2.94	6.71	0.0	0.0	14.62	1.23	0.02
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	3.84	0.0	5.36	3.82	0.0	10.97	4.59
D.EN	0.99	0.0	0.98	0.98	0.0	4.49	1.39
D.FS	3.06	0.0	4.80	3.06	0.0	6.55	3.39
FO	2.36	2.62	0.18	0.29	3.92	2.85	1.29
FA	8.02	5.63	1.00	1.00	8.09	4.58	3.47
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.25	0.52	0.0	0.29	0.0
MT	4.46	3.07	3.73	2.02	3.63	3.04	3.08
SPH	2.50	0.0	0.44	0.49	0.0	2.13	0.88
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.89	0.0	0.0	0.58	0.0	0.0
AP	1.40	1.21	0.40	0.38	1.25	1.61	0.12
CC	0.50	1.18	1.00	0.59	0.82	0.82	1.36
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	1.01	0.53	0.19	0.35	2.61	0.81	0.54
SUM	99.13	97.93	101.44	99.33	98.83	99.80	99.03

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
872	LW 23-1	892	LR 23-20
911	LW 30-20A	881	LW 23-10
914	LW 30-22	910	LW 30-18B
890	LR 23-18		

TABLE A-5 continued.

	UNIT 5B				UNIT 5C		
Ref. No.	**912**	**913**	**945**	**951**	**845**	**846**	**882**
QZ	0.0	0.0	0.0	11.79	0.0	0.0	0.0
CO	0.47	0.0	0.0	0.0	0.04	1.02	0.0
OR	31.46	24.59	34.21	32.58	27.62	24.14	20.13
AB	27.67	25.83	17.77	0.0	27.71	27.52	23.68
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	27.77	34.02	9.59	0.0	36.71	39.80	36.58
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TH	0.22	0.09	0.53	2.63	0.09	0.09	0.31
GEH	2.11	2.38	6.77	21.03	1.05	0.0	3.57
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.37	2.11	1.30	0.0	0.0	0.0
D.EN	0.0	0.08	0.92	0.78	0.0	0.0	0.0
D.FS	0.0	0.31	1.18	0.44	0.0	0.0	0.0
FO	0.69	1.18	2.18	8.36	0.31	0.25	1.77
FA	4.66	5.01	3.07	5.23	1.87	1.43	4.74
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	0.08	2.72	13.76	7.86	1.69	2.40	2.70
SPH	0.0	0.96	2.65	1.89	0.0	0.0	1.50
PERV	0.36	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.33	0.0	0.0	0.0	0.19	0.13	0.05
AP	1.09	0.43	0.90	0.09	0.21	0.26	0.95
CC	0.0	1.05	1.00	4.41	0.68	1.24	1.18
MGS	0.0	0.0	0.0	0.0	0.0	0.03	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.41	0.27	0.26	1.43	0.73	1.19	0.37
SUM	99.22	99.28	96.90	99.83	98.90	99.50	97.52

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
912	LW 30-20B	845	LW 12-1
913	LW 30-21	846	LW 12-2
945	L10 40.6-41.0	882	LR 23-10
951	L12 78.2-78.5		

TABLE A-5 continued.

	UNIT 5C						
Ref. No.	858	859	860	870	870*	873	874
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.22	0.13	0.56	0.0	0.0	0.0	0.0
OR	22.10	23.90	36.44	1.60	25.70	13.42	22.08
AB	25.42	27.76	27.52	35.14	28.48	14.63	21.06
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	35.16	40.19	9.74	32.85	35.77	33.18	42.53
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.0	0.0	10.28	0.0	0.0	0.0
TH	0.22	0.09	0.44	0.31	0.22	0.22	0.09
GEH	4.31	0.42	7.25	0.0	2.03	0.28	0.28
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	0.0	0.0	0.0	4.67	0.70	11.14	1.31
D.EN	0.0	0.0	0.0	1.46	0.20	3.85	0.44
D.FS	0.0	0.0	0.0	3.38	0.53	7.59	0.91
FO	1.61	0.17	2.47	0.36	0.66	1.80	1.10
FA	5.00	1.69	6.70	0.93	1.89	3.93	2.50
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	5.47	0.0	1.35	0.0
MT	1.45	2.16	2.66	0.0	1.98	3.12	2.63
SPH	0.0	0.0	0.0	0.81	0.34	2.09	1.18
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.56	0.14	0.75	0.0	0.0	0.0	0.0
AP	0.66	0.19	0.83	0.73	0.40	1.66	0.45
CC	0.73	0.77	1.00	0.68	0.82	1.00	0.77
MGS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.89	0.79	0.87	0.52	0.77	0.72	0.94
SUM	98.34	98.40	97.24	99.20	100.49	99.98	98.27

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

* Duplicate sample

Reference No.	Sample No.	Reference No.	Sample No.
858	LW 22-15	870*	LW 22-31B
859	LW 22-16	873	LW 23-2
860	LW 22-16A	874	LW 23-3
870	LW 22-31A		

TABLE A-5 continued.

	UNIT 5C						
Ref. No.	**875**	**894**	**895**	**896**	**898**	**902**	**916**
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	1.29	0.0	0.0
OR	13.25	19.44	13.02	21.06	52.49	24.47	21.16
AB	13.68	22.50	15.67	19.20	24.45	25.31	25.78
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	28.09	44.84	53.74	46.40	14.96	40.35	36.64
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.67	0.0	0.0	0.0	0.0
AC	0.40	3.01	3.82	3.03	0.0	0.20	0.0
TH	0.22	0.22	0.09	0.31	0.22	0.22	0.22
GEH	0.0	0.0	0.0	0.0	0.0	0.0	0.02
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	13.09	1.42	2.17	0.92	0.0	0.25	2.84
D.EN	4.50	0.37	0.61	0.21	0.0	0.07	0.82
D.FS	8.96	1.13	1.66	0.76	0.0	0.19	2.15
FO	2.09	0.50	0.61	0.39	0.61	0.50	0.34
FA	4.59	1.68	1.83	1.52	1.43	1.43	0.99
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.05	0.0	0.0	0.0	0.0	0.0	0.0
MT	4.44	1.28	0.0	1.14	0.99	2.91	4.24
SPH	2.65	0.69	0.64	0.61	0.0	0.69	1.52
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.0	0.0	0.22	0.0	0.0
AP	1.99	0.26	1.21	0.24	0.26	0.26	0.52
CC	0.55	1.50	2.23	2.14	0.81	1.23	1.09
MGS	0.0	0.0	0.0	0.0	0.12	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.96	0.63	0.57	0.48	0.55	0.53	0.70
SUM	99.50	99.47	98.52	98.42	98.40	98.61	99.06

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
875	LW 23-4	898	LW 30-6
894	LW 30-2	902	LW 30-10A
895	LW 30-3	916	LW 30-25
896	LW 30-4		

TABLE A-5 continued.

	UNIT 5C						
Ref. No.	930	931	938	939	941	942	943
QZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OR	31.43	30.71	43.00	29.32	30.78	34.60	35.63
AB	11.74	21.57	8.13	17.69	20.18	21.16	22.43
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	33.65	34.68	39.86	35.74	34.16	31.60	29.93
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.41	0.0	0.0	4.18	2.29	0.0	0.0
TH	0.09	0.22	0.53	0.22	0.22	0.31	0.53
GEH	0.0	1.24	0.0	0.0	0.0	0.32	1.21
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	6.42	1.52	0.0	2.11	1.11	1.40	0.76
D.EN	1.64	0.35	0.0	0.41	0.20	0.27	0.11
D.FS	5.14	1.27	0.0	1.86	0.99	1.24	0.71
FO	0.48	0.43	0.0	0.42	0.41	0.30	0.41
FA	1.67	1.73	2.57	2.09	2.21	1.50	2.79
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	1.28	0.0	0.0	0.0	0.0	0.0	0.0
MT	0.90	3.41	0.65	1.35	2.31	2.35	2.51
SPH	0.56	0.69	0.0	0.76	0.64	0.34	0.44
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.0	0.08	0.0	0.0	0.0	0.0
AP	0.92	0.21	0.50	0.07	0.31	0.07	0.14
CC	1.59	1.34	1.82	2.16	2.91	2.00	2.00
MGS	0.0	0.0	0.60	0.0	0.0	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.26	0.30	0.52	0.21	0.41	0.37	0.35
SUM	98.20	99.69	98.69	98.60	99.41	98.28	99.96

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
930	L1 168.1-168.85	941	L5 214.3-214.9
931	L2 79.0-79.8	942	L6 51.3-51.7
938	L2 271.6-272.0	943	L8 169.2-169.75
939	L5 46.5-46.7		

TABLE A-5 continued.

	UNIT 5C		UNIT 6					MISC.
Ref. No.	**950**	**953**	**924**	**925**	**926**	**927**	**928**	**923**
QZ	0.0	0.0	0.30	2.73	1.26	3.35	5.92	0.0
CO	0.0	0.0	0.29	0.14	0.15	0.12	0.0	0.60
OR	21.71	26.68	0.12	0.24	0.24	0.47	1.12	43.55
AB	23.08	24.90	0.0	0.0	0.0	0.0	0.0	26.32
LC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NEPH	43.17	41.42	0.0	0.0	0.0	0.0	0.0	16.75
CAR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AC	0.0	0.24	0.0	0.0	0.0	0.0	0.0	0.0
TH	0.09	0.09	1.15	1.24	0.78	3.18	2.22	0.04
GEH	0.42	0.0	0.0	0.0	0.0	0.0	0.52	6.02
AKM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE-AK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
D.WO	1.27	0.0	0.0	0.0	0.0	0.0	1.42	0.0
D.EN	0.18	0.0	0.0	0.0	0.0	0.0	0.39	0.0
D.FS	1.20	0.0	0.0	0.0	0.0	0.0	1.10	0.0
FO	0.31	0.14	0.0	0.20	0.0	0.0	1.77	1.48
FA	2.22	2.12	4.34	3.20	2.34	4.61	5.48	2.36
ANDR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MT	2.69	0.85	11.16	2.91	1.38	15.98	4.95	2.54
SPH	0.44	0.0	0.0	0.0	0.0	0.0	0.93	0.0
PERV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU	0.0	0.12	0.60	0.20	0.02	0.51	0.0	0.17
AP	0.28	0.17	10.70	20.64	5.54	18.94	26.51	0.05
CC	1.59	1.65	67.85	64.05	84.73	47.19	42.94	0.41
MGS	0.0	0.08	0.44	0.60	0.56	0.85	0.0	0.0
FL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BAD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_2O	0.33	0.54	0.28	0.32	0.28	0.26	0.35	0.24
SUM	98.98	99.00	97.22	96.44	97.27	95.47	95.64	100.54

Note: For sample descriptions, see Table A-1. Alkalic norms were calculated using the method of LeBas (1973).

Reference No.	Sample No.	Reference No.	Sample No.
950	L11 45.7-46.2	926	Lac 3
953	L13 31.2-32.0	927	Lac 4
924	Lac 1	928	Lac 5
925	Lac 2	923	BC13-5B

TABLE A-6. AVERAGE CHEMICAL COMPOSITIONS* (WEIGHT PERCENT AND PPM) OF LITHOLOGIC UNITS FOR THE LACKNER LAKE ALKALIC ROCK COMPLEX.

	UNIT 3A (N = 13)		UNIT 4A (N = 30)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	46.50	1.21	42.14	9.66
Al_2O_3	16.68	0.81	15.07	4.47
Fe_2O_3	3.54	0.84	5.89	4.53
FeO	6.43	0.56	5.77	3.44
MgO	3.08	0.45	3.50	2.22
CaO	9.39	0.85	9.54	4.44
Na_2O	9.13	0.65	6.62	2.13
K_2O	3.44	0.71	4.00	1.87
TiO_2	0.19	0.18	0.75	0.78
P_2O_5	0.13	0.16	0.92	0.79
MnO	0.53	0.05	0.44	0.21
CO_2	0.40	0.15	0.44	0.38
S	0.01	0.00	0.02	0.02
H_2O+	0.09	0.07	0.19	0.24
H_2O-	0.25	0.03	0.22	0.10
LOI	0.00	0.00	0.00	0.00
TOTAL	99.78	0.44	95.70	18.09
S.G.			0.12	0.66
Ag	<1.00	0.00	<1.00	0.00
As			<1.00	0.00
Ba	263.85	247.00	1075.33	1055.76
Co	8.31	1.32	21.03	13.94
Cr	<3.46	3.76	58.63	152.04
Cu	1.08	8.37	78.33	333.69
Li	5.46	1.71	9.30	12.65
Ni	<5.00	0.00	17.13	32.74
Pb	<0.38	16.39	6.77	13.68
Sb			<4.00	0.00
Zn	222.31	37.12	198.83	171.82
Be	21.92	2.53	10.43	5.46
Mo	<1.00	0.00	<1.30	1.64
Sc	<3.46	5.55	3.27	12.10
Sr	669.23	278.04	1688.33	1376.51
V	33.46	14.34	69.50	58.58
Y	21.15	15.83	38.50	35.65
Ga	11.31	3.04	9.67	2.31
Nb	178.85	208.13	305.67	361.73
Rb	95.38	45.57	109.66	47.24
Zr	830.77	298.29	525.00	537.68
Sn	3.46	3.43	<0.63	3.94
Eu	<100.00	0.00	<100.00	0.00
Yb	4.85	1.14	4.34	3.39
Ce	97.69	48.85	423.79	309.15
La	<100.00	0.00	84.48	216.76
Nd	<100.00	0.00	62.07	174.57

**The average compositions may include duplicate samples or analyses which are not listed in Tables A-2 to A-5.*

TABLE A-6 . CONTINUED.

	UNIT 4B (N = 7)		UNIT 4C (N = 10)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	52.04	0.75	49.72	3.91
Al_2O_3	18.70	0.84	18.25	2.33
Fe_2O_3	3.96	1.38	5.24	3.28
FeO	4.24	0.88	3.91	2.17
MgO	0.76	0.25	1.41	1.39
CaO	3.70	0.64	4.80	3.05
Na_2O	6.85	0.76	7.38	1.32
K_2O	7.27	0.86	6.18	1.47
TiO_2	0.27	0.09	0.49	0.33
P_2O_5	0.26	0.27	0.41	0.39
MnO	0.26	0.07	0.30	0.08
CO_2	0.43	0.18	0.52	0.34
S	0.03	0.01	0.03	0.02
H_2O+	0.28	0.16	0.21	0.16
H_2O-	0.23	0.03	0.25	0.06
LOI	0.00	0.00	0.00	0.00
TOTAL	99.31	0.64	99.10	0.81
S.G.				
Ag	<1.00	0.00	<1.00	0.00
As				
Ba	1315.71	748.11	2024.00	1429.15
Co	2.00	6.61	10.70	10.54
Cr	23.86	16.15	19.10	18.28
Cu	9.29	6.73	15.00	8.50
Li	5.00	3.74	8.60	5.36
Ni	1.57	9.52	5.60	11.65
Pb	<0.71	11.70	5.50	21.92
Sb				
Zn	82.14	13.50	147.50	95.37
Be	5.00	0.82	9.80	3.88
Mo	<1.00	0.00	<1.00	0.00
Sc	<5.00	0.00	<2.40	5.56
Sr	1100.00	276.89	2220.00	1709.32
V	2.86	16.04	38.50	44.35
Y	<4.29	15.12	18.00	28.98
Ga	10.14	2.19	12.40	3.44
Nb	71.43	108.08	252.00	291.01
Rb	175.71	54.12	161.00	44.58
Zr	250.00	119.02	435.00	395.14
Sn	<1.86	3.02	<1.10	4.18
Eu	<100.00	0.00	<100.00	0.00
Yb	0.14	1.46	1.80	1.55
Ce	165.71	41.98	353.00	232.67
La	<100.00	0.00	40.00	194.08
Nd	<100.00	0.00	25.00	167.08

TABLE A-6 . CONTINUED.

	UNIT 5A (N = 13)		UNIT 5B (N = 9)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	51.45	1.71	48.54	3.07
Al_2O_3	20.38	1.21	19.48	3.26
Fe_2O_3	3.40	1.06	3.24	2.61
FeO	3.85	1.49	5.19	1.51
MgO	0.75	0.45	1.79	1.59
CaO	2.94	0.99	4.99	3.57
Na_2O	7.45	1.39	6.63	2.82
K_2O	7.02	0.66	6.36	0.91
TiO_2	0.38	0.27	0.56	0.29
P_2O_5	0.25	0.15	0.26	0.22
MnO	0.23	0.06	0.28	0.11
CO_2	0.36	0.15	0.60	0.51
S	0.03	0.02	0.06	0.10
H_2O+	0.40	0.63	0.48	0.72
H_2O-	0.26	0.04	0.29	0.10
LOI	0.00	0.00	0.00	0.00
TOTAL	99.15	0.87	98.77	0.88
S.G.				
Ag	<1.00	0.00	<1.00	0.00
As				
Ba	2024.62	1918.21	1981.11	1816.16
Co	7.38	3.95	12.78	11.37
Cr	8.15	9.15	60.78	143.31
Cu	9.77	5.37	22.78	24.18
Li	12.69	20.52	24.89	36.88
Ni	<5.00	0.00	15.67	39.21
Pb	7.69	20.17	16.67	12.75
Sb				
Zn	101.92	56.96	140.00	42.79
Be	7.00	1.83	8.00	2.24
Mo	<1.00	0.00	<1.00	0.00
Sc	<4.23	2.77	<1.67	6.61
Sr	1984.62	1589.47	2388.89	1980.81
V	6.54	13.90	35.00	43.52
Y	<2.31	18.89	23.89	17.81
Ga	11.00	2.83	9.67	2.06
Nb	218.46	187.12	305.56	211.31
Rb	166.15	44.07	155.56	42.75
Zr	252.31	81.05	266.67	43.30
Sn	<2.08	2.25	<2.22	2.33
Eu	<100.00	0.00	<100.00	0.00
Yb	0.31	1.60	1.22	1.48
Ce	300.00	199.96	387.78	244.94
La	<57.69	103.77	11.11	176.38
Nd	<80.77	69.34	<5.56	146.72

TABLE A-6 . CONTINUED.

	UNIT 5C (N = 27)		UNIT 6 (N = 6)	
	Mean	Std. Deviation	Mean	Std. Deviation
SiO_2	50.61	2.41	4.29	3.48
Al_2O_3	22.00	2.39	0.24	0.09
Fe_2O_3	2.07	1.56	4.33	4.13
FeO	3.04	1.79	4.36	2.51
MgO	0.69	0.70	0.45	0.37
CaO	2.60	1.86	44.90	5.59
Na_2O	8.60	1.55	0.66	0.44
K_2O	7.20	1.50	0.07	0.06
TiO_2	0.36	0.25	0.29	0.25
P_2O_5	0.23	0.20	4.51	3.19
MnO	0.16	0.09	0.30	0.09
CO_2	0.63	0.32	29.87	8.20
S	0.02	0.01	0.39	0.28
H_2O+	0.34	0.22	0.02	0.04
H_2O-	0.25	0.07	0.27	0.01
LOI	0.00	0.00	0.00	0.00
TOTAL	98.78	0.79	96.63	1.59
S.G.				
Ag	<1.00	0.00	<1.00	0.00
As				
Ba	2644.81	1624.28	456.67	101.72
Co	5.37	7.05	9.00	3.46
Cr	1.85	7.69	<3.33	4.08
Cu	8.63	7.32	25.83	3.76
Li	10.48	4.81	1.33	3.44
Ni	<3.70	4.72	<3.33	4.08
Pb	9.07	15.07	60.00	11.83
Sb				
Zn	87.59	44.77	120.83	77.55
Be	7.19	2.48	1.83	3.37
Mo	<1.00	0.00	7.50	20.82
Sc	<4.15	3.07	<5.00	0.00
Sr	2700.00	1117.69	2.57	0.65
V	5.56	25.09	49.17	41.52
Y	2.59	22.72	283.33	60.55
Ga	9.37	2.90	1.50	2.07
Nb	192.59	128.44	2583.17	3759.08
Rb	148.89	62.16	<6.67	8.16
Zr	215.56	160.15	266.67	81.65
Sn	<2.70	1.54	6.00	8.07
Eu	<100.00	0.00	<100.00	0.00
Yb	<0.37	1.42	14.17	2.04
Ce	251.85	227.06	1668.33	410.24
La	<37.04	137.00	1500.00	547.72
Nd	<61.11	112.09	2166.67	1032.80

References

AGI

1972: Glossary of Geology; American Geological Institute, Washington, D.C., 805p.

Badham, J.P.N.

1978: Magnetite-Apatite-Amphibole-Uranium and Silver-Arsenide Mineralizations in the Lower Proterozoic Igneous Rocks, East Arm, Great Slave Lake, Canada; Economic Geology, vol.73, p.1474-1491.

Badham, J.P.N. and Morton, R.P.

1976: Magnetite-Apatite Intrusions and Calc-Alkaline Magmatism, Camsell River, N.W.T.; Canadian Journal of Earth Sciences, vol.13, p.348-354.

Bailey, D.K.

1974: Nephelinites and Ijolites; p.53-66 *in* Alkaline Rocks, edited by H. Sorenson, John Wiley, Toronto.

Bell, K., and Blenkinsop, J.

1980: Ages and Initial ^{87}Sr-^{86}Sr Ratios from Alkalic Complexes of Ontario; p.16-23 in Geoscience Research Grant Program, Summary of Research 1979-1980, Ontario Geological Survey Miscellaneous Paper 93.

Bennett, G., Brown, D.D., George, P.T. and Leahy, E.J.

1967: Operation Kapuskasing; Ontario Division Mines, Miscellaneous Paper 10, 98p.

Boettcher, A.L. and O'Neil, J.R.

1980: Stable Isotope, Chemical and Petrographic Studies of High Pressure Amphiboles and Micas; Evidence for Metasomatism in the Mantle Source Regions of Alkali Basalts and Kimberlites; American Journal of Science, vol.280-A, p.594-621.

Emslie, R.F.

1975: Major Rock Units of the Morin Complex, Southwestern Quebec; Geological Survey of Canada, Paper 74-48, 37p.

Freestone, I.C., and Hamilton, D.L.

1980: The Role of Liquid Immiscibility in the Genesis of Carbonatites - An Experimental Study; Contributions to Mineralogy and Petrology, vol.73, p.105-117.

Gittins, J.

1979: The Feldspathoidal Alkaline Rocks; p.351-390 *in* The Evolution of the Igneous Rocks, Yoder, H.S., Jr., editor, Princeton University Press, Princeton, New Jersey.

Gittins, J., MacIntyre, R.M. and York, D.

1967: The Ages of Carbonatite Complexes in Eastern Canada; Canadian Journal of Earth Sciences, vol.4, p.651-655.

Graham, A.R.

1955: Cerianite CeO_2: A New Rare-Earth Oxide Mineral; American Mineralogist, vol.40, p.560-564.

Hamilton, D.L., Freestone, S.C., Dawson, J.B., and Donaldson, C.M.

1979: Origin of Carbonatite by Liquid Immiscibility; Nature, vol.279, p.52-54.

Heinrich, E. W.

1966: Geology of Carbonatites; Rand McNally and Co., 555p.

Hodder, R.W.

1958: Alkaline Rocks and Niobium Deposits near Nemegos, Ontario; Geological Survey of Canada, Paper 57-8, 15p.

1959: Alkaline Rocks and Niobium Deposits near Nemegos, Ontario; *unpublished* Ph.D. dissertation, University of California, 140p.

1961: Alkaline Rocks and Niobium Deposits near Nemegos, Ontario; Geological Survey of Canada, Bulletin 70, 75p.

Innes, M.J.S.

1960: Gravity and Isostasy in Northern Ontario and Manitoba; Dominion Observatory, Ottawa, vol.21, pt.6, p.265-338.

Irvine, T.N., and Barager, W.R.A.

1971: A Guide to the Chemical Classification of the Common Volcanic Rocks; Canadian Journal of Earth Sciences, vol.8 p.523-548.

Kidd, R.

1979: Report on 1978-1979 Drilling Program Multi-Minerals Ltd., McNaught Township Province of Ontario; *unpublished report prepared for* Multi-Minerals Ltd., 24p.

Kolker, A.

1982: Mineralogy and Geochemistry of Fe-Ti Oxide and Apatite (Nelsonite) Deposits and Evaluation of the Liquid Immiscibility Hypothesis; Economic Geology, vol.77, p.1146-1158.

Lawson, A.C.

1896: Malignite: A Family of Basic Plutonic Orthoclase Rock Rich in Alkalies and Lime, Intrusive in the Couchiching Schists of Poohbah Lake; University of California, Publication Bulletin, Department of Geology, vol.1, p.337-362.

LeBas, M.J.

1973: A Norm for Feldspathoidal and Melilitic Igneous Rocks; Journal of Geology, vol.81, p.89-96.

1977: Carbonatitic-Nepheline Volcanism; Wiley, London, 347p.

1981: Carbonatite Magmas; Mineralogical Magazine, vol.44, p.133-140.

LeBas, M.J. and Aspen, J.A.

1981: The Comparability of Carbonatite Fluid Inclusions in Ijolites with Natrocarbonatite Lava; Bulletin of Volcanology, vol.44-3, p.429-438.

LeBas, M.J., Aspen, J.A. and Woolley, A.R.

1977: Contrasting Sodic and Potassic Inclusions in Apatite Crystals from Ijolite; Journal of Petrology, vol.18, pt.2, p.247-262.

LeBas, M.J., and Handley, C.D.

1979: Variation in Apatite Composition in Ijolitic and Carbonatitic Igneous Rocks; Nature, vol.279, p.54-56.

Lloyd, F.E. and Bailey, D.K.

1975: Light Element Metasomatism of the Continental Mantle: The Evidence and Consequences; p.389-416 *in* Physics and Chemistry of the Earth, Ahrens, L.H., Dawson, J.B., Duncan, A.R. and Erlank, A.J., editors, vol.9.

Mitchell, R.H., and Platt, G.R.

1978: The Poohbah Lake Alkaline Complex and the Nature of Malignite; p.93-104 *in* Proceedings of the First International Symposium on Carbonatites, 1976, Ministerio das Minas E Energia Departamento Nacional da Producao Mineral, Pocos de Caldas, Minas Gerais, Brazil, 324p..

Naldrett, A. J.

1959: Report on Project No. 548, Lackner and McNaught Townships; private files of Falconbridge Nickel Mines Ltd., 24p. plus appendix.

Nash, W.P.

1972: Mineralogy and Petrology of the Iron Hill Carbonatite Complex, Colorado; Geological Society of America, Bulletin, vol.83, p.1361-1382.

Neczkar, E.

1958: Paragenesis of the Rock-Forming Minerals of the Nepheline Syenite and Adjacent Wallrocks, near Nemegos, Ontario; *unpublished* M.A.Sc. thesis, University of Toronto, 125p.

Nickel, E.H.

1955a: Interim M.D. Test Report 710-ML; Mines Branch, Department of Mines and Technical Surveys Canada, 11p.

1955b: Interim M.D. Test Report 716-ML; Mines Branch, Department of Mines and Technical Surveys Canada, 13p.

1956: Report MD3112; Mines Branch, Department of Mines and Technical Surveys Canada, 16p.

Nie, N.H., Hadlaihull, C., Jenkins J.G., Steinbuenner, K. and Beat, D.H.

1975: Statistical Package for the Social Sciences; 2nd Edition, McGraw-Hill, 675p.

ODM-GSC

1963: Chapleau; Ontario Department of Mines - Geological Survey of Canada, Aeromagnetic Map 2232G, scale 1 inch to 1 mile.

1970: Albany River; Ontario Department of Mines - Geological Survey of Canada, Aeromagnetic Compilation Map P.578, scale 1 inch to 16 miles.

Owens, L.B., and Faure, G.

1977: Rb-Sr Dating of the Lackner Lake Complex, Northern Ontario, Canada; Precambrian Research, vol.5, p.299-303.

Parsons, G.E.

1955: Geology of Lackner Township - Fire Tower Area (Scott Claims), Swayze Area; *unpublished report prepared for* Gulf Minerals Canada Ltd., 12p. plus appendix.

1961: Niobium-Bearing Complexes East of Lake Superior; Ontario Department of Mines, Geological Report 3, 73p.

Philpotts, A.R.

1967: Origin of certain Iron-Titanium Oxide and Apatite Rocks; Economic Geology, vol.62, p.303-315.

Rankin, A.H. and LeBas, M.J.

1974a: Liquid Immiscibility between Silicate and Carbonate Melts in naturally occurring Ijolite Magmas; Nature, vol.250, p.206-209.

1974b: Nahcolite in Inclusions in Apatites from some African Ijolites and Carbonatites; Mineralogical Magazine, vol.39, p.564-570.

Scott, S.D.

1963: The System Magnetite-Fluorapatite-Water and its Relation to Multi-Minerals No. 6 Orebody, Nemegos, Ontario; *unpublished* B.A.Sc. thesis, University of Western Ontario, 58p.

Sorensen, H.

1974: The Alkaline Rocks; John Wiley and Sons, New York, 622p.

Thurston, P.L., Siragusa, G.M., and Sage, R.P.

1977: Geology of the Chapleau Area, Districts of Algoma, Sudbury, and Cochrane; Ontario Division of Mines, Geoscience Report 157, 293p.

Van Kooten, G.K.

1980: Mineralogy, Petrology and Geochemistry of an Ultrapotassic Basaltic Suite, Central Sierra Nevada, California, U.S.A.; Journal of Petrology, vol.21, pt.4, p.651-684.

Watkinson, D.H.

1973: Pseudoleucite from Plutonic Alkalic Rock - Carbonatite Complexes; Canadian Mineralogist, vol.12, p.129-134.

Williams, H., Turner, R., and Gilbert, C.

1954: Petrography; W.H. Freeman and Co., San Francisco, 406p.

Wilson, H.D.B., and Brisbin, W.C.

1965: The Mid-North American Ridge Structure; p.186-187 *in* Abstracts for 1965, Geological Society of America, Special Paper 87.

Wyllie, P.J. and Tuttle, O.F.

1960: The System $CaO-CO_2-H_2O$ and the Origin of Carbonatites; Journal of Petrology, vol.1, pt.1, p.1-46.

Yudintsev, S.V., Xuan, P.T., Gramenitskiy, Ye.N. and Shchekina, T.I.

1984: Experimental Modeling of Formation of Nepheline Syenite Pegmatite; Doklady, vol.268, p.119-122.

Zyryanov, V.N.

1981: Phase Relations in the Lc_{55}-Ne_{55}-Fsp-$(K,Na)Cl^m$ System and the Pseudoleucite Problem; Geochemistry International, vol.18, no.3, p.23-31.

Index

A

Aegirine-augite
  See also Clinopyroxene, Pyroxene
  Carbonatite, 22
  Gneiss, 11
  Magnetite & magnetite-apatite veins, 23

Aeromagnetic data, 8
  Map, 8

AFM data, 26

AFM plot
  Carbonatite, 27
  Coarse-grained, mesocratic to leucocratic nepheline syenite to malignite, 27
  Ijolite & ijolite breccia, 27
  Leucocratic, foliated nepheline syenite, 27
  Melanocratic, foliated ijolite to malignite, 27
  Mesocratic to melanocratic, unfoliated nepheline syenite, malignite & ijolite, 27
  Mesocratic, foliated malignite to nepheline syenite, 27

Albite
  Alkorthosite, 20
  Lamprophyre, 24
  Mesocratic to leucocratic nepheline syenite to malignite, 19

Alkali feldspar, Gneiss, 10—11

Alkalic mafic rocks, 8

Alkorthosite, Petrology, 20

Alumina, Nepheline syenite, Falconbridge Nickel Mines Ltd., 46

Amphibole
  Mesocratic to leucocratic nepheline syenite to malignite, 19
  Mesocratic to melanocratic malignite & ijolite, 18

Analyses
  AFM plots, 27
  Average chemical compositions
    Carbonatite, 132
    Ijolite, foliated, 129
    Ijolite, massive, 129
    Malignite to ijolite, mesocratic to melanocratic, 131
    Malignite, foliated, 130
    Nepheline syenite to malignite, mesocratic to leucocratic, 132
    Nepheline syenite, foliated, 130
    Nepheline syenite, mesocratic, 131
    Sovite, 132
  Average electron microprobe
    Feldspar, 21
    Nepheline, 21
    Pseudoleucite, 21
  Chemical
    Cerianite, 39
    Magnetite-apatite veins, 39
    Pyrochlore, 37
  Major element
    Carbonatite, 83
    Ijolite, foliated, 76, 77, 78
    Ijolite, massive, 76
    Malignite to ijolite, mesocratic to melanocratic, 80, 81
    Malignite, foliated, 78, 79
    Nepheline syenite to malignite, mesocratic to leucocratic, 81, 82, 83
    Nepheline syenite, foliated, 79
    Nepheline syenite, mesocratic, 79, 80
    Nepheline syenite, pseudoleucite, 83
  Normative minerals (alkalic rocks)
    Carbonatite, 128
    Ijolite, foliated, 115, 116, 117, 118, 119
    Ijolite, massive, 114, 115
    Malignite to ijolite, mesocratic to melanocratic, 123, 124
    Malignite, foliated, 119, 120
    Nepheline syenite to malignite, mesocratic to leucocratic, 124, 125, 126, 127, 128
    Nepheline syenite, foliated, 120, 121
    Nepheline syenite, mesocratic, 121, 122, 123
    Nepheline syenite, pseudoleucite, 128
    Sovite, 128
  Normative minerals (CIPW norm)
    Ijolite, foliated, 100, 101, 102, 103, 104
    Ijolite, massive, 99, 100
    Malignite to ijolite, mesocratic to melanocratic, 108, 109
    Malignite, foliated, 104, 105
    Nepheline syenite to malignite, mesocratic to leucocratic, 109, 110, 111, 112, 113
    Nepheline syenite, foliated, 105, 106
    Nepheline syenite, mesocratic, 106, 107, 108
    Nepheline syenite, pseudoleucite, 113
  Rare earth elements, Apatite, 40
  Rb/Sr isochron plot, 33
  Spectrographic, Magnetite-apatite, 42—44
  Trace element
    Carbonatite, 98
    Ijolite, foliated, 85, 86, 87, 88, 89
    Ijolite, massive, 84, 85
    Malignite to ijolite, mesocratic to melanocratic, 93, 94
    Malignite, foliated, 89, 90
    Nepheline syenite to malignite, mesocratic to leucocratic, 94, 95, 96, 97, 98
    Nepheline syenite, foliated, 90, 91
    Nepheline syenite, mesocratic, 91, 92, 93

Nepheline syenite, pseudoleucite, 98
Sovite, 98

Anomaly, 8, 36
See also Aeromagnetic data
Apatite-magnetite pods, 45
Foliated alkalic rocks, 45
Foliated ijolite, 45
Portage Lake Complex, 14, 45

Apamag Mines Ltd., 40, 41
Property description, 44

Apatite, 39, 49
Carbonatite, 22
Chemical analyses, 38
Dominion Gulf Co., 45
Foliated ijolite, malignite & nepheline syenite, 16
Geochronology, Rb/Sr isochron plot, 33
Multi-Minerals Ltd., 49
Rare earth element analyses, Multi-Minerals Ltd., 40

Apatite-magnetite mineralization, Vertical section, Multi-Minerals Ltd., 48, 50

Assays
Niobium, Multi-Minerals Ltd., 47
Uranium, Multi-Minerals Ltd., 47

Augen, Gneiss, 10

B

Biotite
Carbonatite, 22
Foliated ijolite, malignite & nepheline syenite, 15
Gneiss, 11
Ijolite, 13
Magnetite & magnetite-apatite veins, 23
Mesocratic nepheline syenite, 17
Mesocratic to leucocratic nepheline syenite to malignite, 19
Mesocratic to melanocratic malignite & ijolite, 18
Metamorphism, 34
Schistosity, 35

Breccia, 30

Breccia zones, Magnetite & magnetite-apatite veins, 23

Breccia, ijolitized, Petrology, AFM data, 26

Burton, M., 47

C

Calcite
Carbonatite, 22
Gneiss, 11
Lamprophyre, 24

Carbonate, Carbonatite, 22

Carbonate rock
Cerianite, 38
Pyrochlore, 37

Carbonated alkalic mafic magma, Petrogenesis, 28, 30, 31

Carbonatite, 9
AFM plot, 27
Analyses
Average chemical compositions, 132
Major element, 83
Normative minerals (alkalic rocks), 128
Trace element, 98
Geochronology, Rb/Sr isochron plot, 33
Petrology, 21—22
AFM data, 26
Petrogenesis, 25

Carbonatite magma, Petrogenesis, 26, 29

Cerianite, 38
Chemical analyses, Dominion Gulf Co., 39

Chyka Mines Ltd., 9, 13, 40, 41
Property description, 45

Claymac Mines Ltd., 40, 41
Property description, 45

Clinopyroxene
Aegirine-augite
Foliated ijolite, malignite & nepheline syenite, 15
Ijolite, 13
Mesocratic nepheline syenite, 17
Metamorphism, 34

Copper, Multi-Minerals Ltd., 48

D

Derraugh Lackner Incorporated, 46

Diabase, 11

Diamond drilling, 41

Dike rocks, 11
Petrology, 24

Dominion Gulf Co., 40, 41
Cerianite, 38
Chemical analyses, 39
Property description, 45

E

Economic geology, 37—53

F

Falconbridge Nickel Mines Ltd., 40, 41
Magnetite-apatite, Spectrographic analyses, 42—44
Property description, 45—46
Reserves, 41

Faulting, 35

Faulting, regional, 34

Feldspar
Analyses, Average electron microprobe, 21
Trachytoidal texture, 35

Feldspar, alkali
Alkorthosite, 20

Geochronology, Rb/Sr isochron plot, 33
Lamprophyre, 24
Magnetite & magnetite-apatite veins, 23

Fenitization, 34
Gneissic rock, 32

Fetio Industrial Developments Ltd., 47

Foliated rocks, Radioactivity, 36

Foliated units, Petrology, AFM data, 26

Foliation, 28, 30, 35
Ijolite, malignite, nepheline syenite, 14
Primary banding, 14
Schistosity, 14
Trachytoidal, 14

Fracture, arcuate ring, Carbonatite, 28

Fractures, cone sheet
Magnetite & magnetite-apatite veins, 23
Magnetite-apatite veins, 25

Fractures, ring-dike
Lamprophyre, 24
Mafic dike, 24

G

Garnet, Foliated ijolite, malignite & nepheline syenite, 15

Geochronology, 8, 11, 32
Rb/Sr isochron plot, 33

Gneiss, 9
Biotite-pyroxene, 9
Petrology, 9—11

Gneissic rocks, Metamorphism, 32

Gneissosity, 35

H

Hornfels, 32

Horst structure, 34

Hybridization, 24, 30

I

Ijolite
AFM plot, 27
Geochronology, Rb/Sr isochron plot, 33
gneissosity, 35
Metamorphism, 32
Nepheline syenite, Photo, 12
Nomenclature, 6
Petrology, 13—14, 56, 63, 64, 65—67, 69—70, 71—72, 73, 74
AFM data, 26
Petrogenesis, 25, 26
Photo, 12
Pyrochlore, 37
Chemical analyses, 37
Multi-Minerals Ltd., 49
Radioactivity, 36

Ijolite breccia, Petrology, 11—14

Ijolite magma, Petrogenesis, 29, 30

Ijolite, biotite, Petrology, 54, 55, 59, 72—73, 75

Ijolite, biotite - garnet, Petrology, 62

Ijolite, biotite - pyroxene - nepheline, Petrology, 72

Ijolite, foliated
Analyses
Average chemical compositions, 129
Major element, 76, 77, 78
Normative minerals (alkalic rocks), 115, 116, 117, 118, 119
Normative minerals (CIPW norm), 100, 101, 102, 103, 104
Trace element, 85, 86, 87, 88, 89
Anomalies, 36
Petrology, 14—16

Ijolite, magnetite, Petrology, 69

Ijolite, massive
Analyses
Average chemical compositions, 129
Major element, 76
Normative minerals (alkalic rocks), 114, 115
Normative minerals (CIPW norm), 99, 100
Trace element, 84, 85
Petrology, 11—14

Ijolite, mesocratic to melanocratic, Petrology, 17—18

Ijolite, pyroxene - garnet, Petrology, 68

Ijolitic magma, Petrogenesis, 28

Inclusion rings, 32

Inclusions
Carbonatite, 22
Foliated ijolite, malignite & nepheline syenite, 14—15
Nepheline, Foliated ijolite, malignite & nepheline syenite, 15
Perthite
Foliated ijolite, malignite & nepheline syenite, 15
Mesocratic nepheline syenite, 17

Iron, Dominion Gulf Co., 45

K

Kapuskasing Structural Zone, 9, 28, 34

L

Lamprophyre dikes, Petrology, 24

LeBrasseur Lackner Inc., 46

Lithologic units, Table, 10

M

M. Silverman Claims, Property description, 52

MacDonnell Lackner Inc., 46

MacDonnell-LeBrasseur-Derraugh, 40, 41
Property description, 46—47

Magnetic data, 35, 36

Magnetite, 17, 49
  Alkorthosite, 20
  Carbonatite, 22
  Foliated ijolite, malignite & nepheline syenite, 16
  Geochronology, Rb/Sr isochron plot, 33
  Ijolite, 11
  Lamprophyre, 24
  Malignite to ijolitic malignite, Multi-Minerals Ltd., 51
  Multi-Minerals Ltd., 49
  Nepheline syenite, Photo, 12

Magnetite veins, 38
  Anomalies, 36
  Petrology, 22—23

Magnetite-apatite
  Chemical analyses, Lackner Lake Complex, 39
  Pyrochlore, 37
  Spectrographic analyses, Falconbridge Nickel Mines Ltd., 42—44

Magnetite-apatite bodies, Anomalies, 36

Magnetite-apatite dikes, 9
  Petrology, 31

Magnetite-apatite veins, 38
  Petrology, 22—23
    Petrogenesis, 25, 26

Malignite
  AFM plot, 27
  Analyses, Average electron microprobe, 21
  Anomalies, 36
  Nomenclature, 6
  Petrogenesis, 30
  Petrology, 14—16, 55, 56, 57—58, 61—62, 67, 71, 73—74
    Petrogenesis, 25
  Pyrochlore, 37

Malignite to ijolite, mesocratic to melanocratic, Analyses
  Average chemical compositions, 131
  Major element, 80, 81
  Normative minerals (alkalic rocks), 123, 124
  Normative minerals (CIPW norm), 108, 109
  Trace element, 93, 94

Malignite, amphibole, Petrology, 55—56, 57

Malignite, foliated
  Analyses
    Average chemical compositions, 130
    Major element, 78, 79
    Normative minerals (alkalic rocks), 119, 120
    Normative minerals (CIPW norm), 104, 105
    Trace element, 89, 90
  Pyrochlore, Chemical analyses, 37

Malignite, mesocratic to leucocratic, Petrology, 18—19

Malignite, mesocratic to melanocratic, Petrology, 17—18

Malignite, porphyritic, Petrology, 58, 60—61

Matrix, Pseudoleucite nepheline syenite, 21

McVittie pit, Magnetite veins, 38

Mertec Resource Development Ltd., 47

Metamorphism, 32—34

Metamorphism, contact, 28

Multi-Minerals Ltd., 9, 12, 40, 41
  Magnetite-apatite deposits, 38
    Chemical analyses, 38
  Property description, 47—51
  Pyrochlore, Chemical analyses, 37
  Rare earth elements, Chemical analyses, 40
  Reserves, 41

Multiwin Explor. Ltd., 9
  Property description, 52

N

Naneck Mines Ltd., Property description, 52

Nemegos Uranium Corp., 47

Nepheline
  Alkorthosite, 20
  Analyses, Average electron microprobe, 21
  Foliated ijolite, malignite & nepheline syenite, 15
  Geochronology, Rb/Sr isochron plot, 33
  Ijolite, 13
  Magnetite & magnetite-apatite veins, 23
  Mesocratic nepheline syenite, 17
  Mesocratic to leucocratic nepheline syenite to malignite, 19
  Mesocratic to melanocratic malignite & ijolite, 18

Nepheline stringers, Pyrochlore, 37

Nepheline syenite, 8—9
  AFM plot, 27
  Dike, Photo, 12
  Dikes, Ijolite, 11
  Geochronology, Rb/Sr isochron plot, 33
  Gneissosity, 35
  Metamorphism, 32
  Petrology, 14—16, 54, 63
    AFM data, 26
    Petrogenesis, 25
  Pseudoleucite, Photo, 20
  Trachytoidal texture, 35
  Veinlet, Photo, 12
  Veinlets, Ijolite, 11

Nepheline syenite magma, Petrogenesis, 28, 29, 30

Nepheline syenite to malignite, mesocratic to leucocratic, Analyses
  Average chemical compositions, 132

Major element, 81, 82, 83
Normative minerals (alkalic rocks), 124, 125, 126, 127, 128
Normative minerals (CIPW norm), 109, 110, 111, 112, 113
Trace element, 94, 95, 96, 97, 98

Nepheline syenite, aegirine-augite, Petrology, 71, 73, 74

Nepheline syenite, amphibole - biotite, Petrology, 68

Nepheline syenite, amphibole - pyroxene, Petrology, 59—60, 75

Nepheline syenite, biotite, Petrology, 65, 72

Nepheline syenite, biotite - aegirine-augite, Petrology, 73

Nepheline syenite, biotite - amphibole, Petrology, 57, 68

Nepheline syenite, biotite - pyroxene, Petrology, 55, 56, 59, 60, 61, 63—65, 67, 68—69, 73

Nepheline syenite, biotite - pyroxene - amphibole, Petrology, 57, 67—68

Nepheline syenite, foliated
Analyses
Average chemical compositions, 130
Major element, 79
Normative minerals (alkalic rocks), 120, 121
Normative minerals (CIPW norm), 105, 106
Trace element, 90, 91
Metamorphism, 32

Nepheline syenite, ijolitic, Geochronology, Rb/Sr isochron plot, 33

Nepheline syenite, leucocratic to melanocratic, Petrology, AFM data, 26

Nepheline syenite, mesocratic
Analyses
Average chemical compositions, 131
Major element, 79, 80
Normative minerals (alkalic rocks), 121, 122, 123
Normative minerals (CIPW norm), 106, 107, 108
Trace element, 91, 92, 93
Petrology, 16—17

Nepheline syenite, mesocratic to leucocratic, Petrology, 18—19

Nepheline syenite, pseudoleucite
Analyses
Major element, 83
Normative minerals (alkalic rocks), 128
Normative minerals (CIPW norm), 113
Trace element, 98
Petrology, 20—21

Nepheline syenite, pseudoleucite - pyroxene, Petrology, 70

Nepheline syenite, pyroxene, Petrology, 58—59, 61, 62, 63, 64, 65, 68

Nepheline syenite, pyroxene - amphibole, Petrology, 62

Nepheline syenite, pyroxene - biotite, Petrology, 60, 66

Niobium, 49
Assays, Multi-Minerals Ltd., 47
Carbonatite dike, Multi-Minerals Ltd., 51
Claymac Mines Ltd., 45
Dominion Gulf Co., 45
M. Silverman Claims, 52
MacDonnell-LeBrasseur-Derraugh, 47
Multi-Minerals Ltd., 49, 51
Ontario Rare Metal Mines Ltd., 52

Niobium mineralization, Vertical section, Multi-Minerals Ltd., 48

Niobium zone, Vertical section, Multi-Minerals Ltd., 51

Northrim Exploration Co., 47

O

Ontario Rare Metal Mines Ltd., 9, 40, 41
Property description, 52

P

Perthite
Foliated ijolite, malignite & nepheline syenite, 15
Mesocratic nepheline syenite, 17
Mesocratic to leucocratic nepheline syenite to malignite, 19
Mesocratic to melanocratic malignite & ijolite, 18
Metamorphism, 34

Petrogenetic Model 1, 25—30

Petrogenetic Model 2, 30—31

Petrology, 24—31

Phosphorus, Dominion Gulf Co., 45

Plagioclase, Gneiss, 11

Port Coldwell alkalic rock complex, 30

Portage Lake Complex, Petrology, 13—14

Portage Lake complex, 9

Pseudoleucite
Analyses, Average electron microprobe, 21
Nepheline syenite, 20—21
Photo, 20

Pyrochlore, 34, 36, 37—38, 49
Carbonatite, 22
Carbonatite dike, Multi-Minerals Ltd., 51
Chemical analyses, Multi-Minerals Ltd., 37
Dominion Gulf Co., 45
Ijolite, 13

Multi-Minerals Ltd., 49
MacDonnell-LeBrasseur-Derraugh, 47
Magnetite & magnetite-apatite veins, 23
Malignite to ijolitic malignite, Multi-Minerals Ltd., 51
Pyroxene
Aegirine-augite
Mesocratic to leucocratic nepheline syenite to malignite, 19
Mesocratic to melanocratic malignite & ijolite, 18
Alkorthosite, 20
Lamprophyre, 24
Magnetite & magnetite-apatite veins, 23

Q

Quartz, Gneiss, 11

R

Radioactive data, 36
Radioactivity, Multi-Minerals Ltd., 49
Rare earth elements, 39
Chemical analyses, Multi-Minerals Ltd., 40
Rare earth minerals, 36
Recommendations
Future studies, 36
To the prospector, 52—53
Reserves, 41
Riebeckite, Gneiss, 11
Ring dike intrusion, 32
Ring structure, 8

S

Schistosity, 35
Schlieren, Mesocratic nepheline syenite, 16
Shawmere Anorthosite Complex, 9
Silicocarbonatite, Nomenclature, 6
Silver, Multi-Minerals Ltd., 48
Silverman, 40, 41
Sovite
Analyses
Average chemical compositions, 132
Major element, 83
Normative minerals (alkalic rocks), 128
Trace element, 98
Major element, Carbonatite, 83
Nomenclature, 6
Sovite, magnetite - apatite - pyroxene, Petrology, 71
Sovite, pyroxene - apatite, Petrology, 70
Sovite, pyroxene - apatite - magnetite, Petrology, 70—71
Structural geology, 34—35
Syenite
Nomenclature, 6
Petrology, 74—75
Syenitic rocks, unfoliated, Petrology, 20—21

T

Texture, Foliated ijolite, malignite & nepheline syenite, 14—15
Thorium
Multi-Minerals Ltd., 47
Pyrochlore, 38
Titanite, Multi-Minerals Ltd., 49
Trachytoidal texture, 35

U

Union Carbide Canada Mining Ltd., 40, 41
Property description, 52
Uranium
Assays, Multi-Minerals Ltd., 47
Pyrochlore, 38

X

Xenoliths, 9, 30
Mesocratic nepheline syenite, 16
Xenoliths, elongated, Gneissosity, 35

Z

Zonation
Aegirine-augite pyroxene
Mesocratic to leucocratic nepheline syenite to malignite, 19
Mesocratic to melanocratic malignite & ijolite, 18
Amphibole, Mesocratic to melanocratic malignite & ijolite, 18
Clinopyroxene
Foliated ijolite, malignite & nepheline syenite, 15
Ijolite, 13
Mesocratic nepheline syenite, 17
Perthite, Mesocratic nepheline syenite, 17
Pseudoleucite, Nepheline syenite, 21
Xenoliths, Mesocratic nepheline syenite, 16

MAPS
NOT
FILMED

CARTES
OMISES